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Volume 19, Number 19, October 15, 1965

NUCLEAR SCIENCE ABSTRACTS

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NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

35877 (JPRS-29788) RECENT DEVELOPMENTS IN SOVIET MEDICINE. Translated from Klinich. Med., 43: 3-27; 85-100(Jan. 1965). 60p. (TT-65-30834). CFSTI, $3.00 cy.

A separate abstract was prepared on one section of this report. Other sections discuss contemporary problems of the medical sciences in the USSR, the use of computers in the diagnosis of diseases, atherosclerosis of the cerebral vessels in the elderly, and physiological shifts of healthy persons in the Arctic. (C.H.)

For an abstract of the individual paper see: 36101.

35878 THE PRESERVATION OF BONE MARROW. Ashwood-Smith, M. J. (Medical Research Council Radiobiological Research Unit, Harwell, Eng.). Cryobiology, 1: 61-3(Sept.-Oct. 1964).

The development of methods for the preservation of bone marrow was traced, and techniques for evaluating its viability are outlined. An evaluation was made of some of the latest additives and procedures for freezing marrow. (TCO)

35879 THE BRAIN LESION OF GOLDTHIOGLUCOSE OBESITY. Brecher, G.; Laqueur, G. L.; Cronkite, E. P.; Edelman, P. M.; Schwartz, I. L. (National Inst. of Arthritis and Metabolic Disease, Bethesda, Md. and Brookhaven National Lab., Upton, N. Y.). J. Exptl. Med., 121: 395-401(Mar. 1, 1965).

The development of hypothalmic lesions in mice due to goldthioglucose are described. The initial extensive necrotic lesion occurs in close to 100% of animals injected with LD_{50}. Within two weeks the necrotic material has been removed and a narrow scar results. After a lapse of several months, the scar is often difficult to visualize, especially in animals that have not developed obesity. The ventromedial nucleus is not the center of the lesion. The nucleus is preserved in some instances, and partially or completely destroyed in others, depending on the extent of the lesion. The more prominent scar in the obese animals correlates with the larger initial lesion necessary for the complete bilateral destruction of the ventromedial nucleus which is known to be a pre-requisite for the development of hypothalamic obesity. Thus, contrary to earlier suggestions, goldthioglucose does not localize specifically in the cells of the ventromedial nucleus. (auth)

35880 FUNGI ISOLATED IN CULTURE FROM SOILS OF THE NEVADA TEST SITE. Durrell, L. W.; Shields, Lora Mangum (New Mexico Highlands Univ., Las Vegas). Mycologia, 52: 636-41(July-Aug. 1960).

Results of culturing 550 soil samples from the site of detonation of nuclear devices are reported, and the taxonomy and characteristics of the fungi isolated are described. Their resistance to uv radiation is also reported. By culture on Rose-Bengal agar containing streptomycin, 41 fungal taxa were isolated from surface and 3- to 6-in. samples of arid soils of the Nevada Test Site. Four taxa developed in from 40 to over 80% of the samples cultured: Stemphylium ilicis, Fusarium sp., Phoma sp., and Penicillium oxalicum. Certain of the species which produced black spores tended to predominate in cultures. Five of these species were also among the 14 isolated from Death Valley soils. The predominance of black-spored species in soils from the Nevada Test Site as well as from Death Valley suggests that in strongly insolated regions the melanin pigment affords a degree of protection. To determine relative resistance of fungal spores to uv light, cultures of a number of species were exposed to wavelength 2573 Å for different periods at 40 $\mu w/cm^2$/min. The time interval within which this exposure was 100% lethal is shown for seven representative species. Certain dark-spored species, as S. ilicis, Stachybotrys atra, and Cladosporium herbarum, survived prolonged exposures. S. ilicis spores were particularly resistant, germinating after 60 min in 95 to 100% of the exposed samples. Spores of Asperigillus niger, also black, were killed by two-min. exposure to uv light. The usual organic solvents did not extract the pigment from S. ilicis spores, while the spore pigment of A. niger dissolved readily in methyl alcohol. When thin layers of these spores attached to a quartz slide were checked by a spectrograph and electrospectrometer for determining light transmission, no light within the range of 2000 to 20,000 Å was seen to pass through Stemphylium spores. In contrast, the extracted pigment from A. niger spores showed a wide transmission band with a peak maximum at 12,000 Å. Spore or nuclear volume also may modify the effect of uv light. Possibly energy absorption is less rapid by large spores, as in Stemphylium sp., than by the small spores of A. niger with about 1/50 the volume. The dark spores of Coccosporium, however, with an approximate volume of 13,000 μ^3 were killed in half the time required for Stemphylium with a spore volume of 8000 μ^3. (auth)

35881 RADIOSENSITIVITY AND BIOLOGICAL PROPERTIES OF TWO TUMOR TYPES INDIGENOUS TO THE SAME HOST. IX. SWELLING PROPERTIES OF MITOCHONDRIA ISOLATED FROM MOUSE TUMOR AND LIVER TISSUE. Miller, Leo A.; Goldfeder, Anna (Dept. of Hospitals, New York and New York Univ., New York). Proc. Soc. Exptl. Biol. Med., 119: 759-63(July 1965).

Isolated mitochondria from 2 tumor types indigenous to DBA/212 inbred strain (an epithelial cell, slower growing, and a spindle cell, faster growing) have relatively low initial OD (520 mμ) per mg protein and a very low rate of mitochondrial swelling. On the other hand, mitochondria from liver from the same strain of mice exhibit a higher initial OD per mg protein and have a high rate of swelling in vitro. Aged liver mitochondria have a much lower initial specific OD and also swell at a very low rate. Thus, it is proposed that the initial OD of isolated mitochondria and its rate of swelling under similar conditions of isola-

tion, resuspension, and incubation is indicative of the inherent quality and integrity of the mitochondrial fraction. Certain conditions of pre-treatment and some specific additives increased mitochondrial swelling of both tumor types, indicating that the mitochondrial integrity of the tumors is at some intermediate state with respect to that of liver mitochondria. (auth)

35882 UROLOGIC COMPLICATIONS IN CARCINOMA OF THE PORTIO WITHOUT RECIDIVATIONS. Hennig, K.; Platzbecker, H. (Carl Gustav Carus, Dresden). Radiobiol. Radiotherap., 6: 319-23(1965). (In German)

Urinary passages were examined in 150 patients treated for liver carcinomas by irradiation, surgery, or a combination of irradiation and surgery. Urologic complications were not found in those receiving radiotherapy only, the majority of such changes occurring after radical surgery. Injuries were found on the right side of the body more frequently than on the left. (H.G.D.)

35883 PENETRATION OF STAIN IN ULTRATHIN SECTIONS OF TOBACCO MOSAIC VIRUS. Shalla, Thomas A.; Carroll, T. W.; DeZoeten, G. A. (Univ. of California, Davis). Stain Technol., 39: 257-65(Sept. 1964).

The use of uranyl acetate and strontium permanganate to stain tobacco mosaic virus (TMV) for electron microscopy of infected plant tissue is discussed. Tissues were treated with uranyl acetate before embedding or sections of embedded tissue were floated on a solution of phosphotungstic acid. The latter method was found to be more effective for staining TMV when solutions of strontium permanganate were used. Attempts were thus made to determine the extent to which embedded particles are stained when sections are floated on solutions of strontium permanganate. In sections containing purified and intracellular virus, the apparent length of stained particles varied directly with section thickness, indicating stain penetration beyond the surface of the section. Penetration was less complete when sections were allowed to dry before staining. In most instances the number of identifiable particles per unit area was independent of section thickness, but increased when both surfaces of the sections were stained instead of only one surface. Staining was prevented by thin films of methacrylate or epoxy resin placed between the virus section and staining solution. Results indicate that electron scattering capacity is enhanced only in particles which intersect the surface of the section exposed to permanganate. (TCO)

35884 (CONF-640305) 5TH INTER-AMERICAN SYMPOSIUM ON THE PEACEFUL APPLICATION OF NUCLEAR ENERGY. Symposium Held at Valparaiso, Chile, Mar. 9-13, 1964. (Inter-American Nuclear Energy Commission, Washington, D. C.). 1965. 300p. Washington, D. C., Pan American Union. $3.50.

Separate abstracts were prepared for 34 papers presented at this symposium. Abstracts for 4 papers were previously prepared and appeared in NSA Vol. 18 as numbers 4925 and 35323, and Vol. 19 as numbers 2014 and 25914. (C.H.)

For abstracts of individual papers see: 35885, 35891, 35931, 35932, 35933, 35934, 35935, 35936, 35937, 35938, 35939, 35940, 35941, 35942, 36085, 36090, 36091, 36092, 36093, 36094, 36095, 36096, 36097, 36098, 36099, 36122, 36123, 36313, 36314, 36315, 36517, 36518, 36883, and 36884.

35885 THE BACTERIOPHAGE CHROMOSOME. Thomas, C. A. Jr. (Johns Hopkins Hospital, Baltimore). pp 111-19 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

All of the bacteriophage that have been studied contain a single molecule of DNA. These molecules are a duplex of polynucleotide chains, and have the linear mass density expected from the crystalline B form which has been analyzed by x-ray diffraction. In the case of T_2 DNA molecules, the two polynucleotide chains appear to be uninterrupted and continuously linked from one end of the molecule to the other. T_5 DNA molecules may have some special points. Some recent experiments based on the renaturation phenomena have shown that the T_2 DNA molecules appear to have nucleotide sequence which differ slightly from molecule to molecule: each molecule seems to have a sequence which would result from the single random breakage of a circular molecule, itself of specified sequence. On the other hand, T_5 DNA molecules are not circular permutations of each other; they appear to be a collection of unique sequences. The DNA from λ bacteriophage must be a collection of unique nucleotide sequences as shown by the work of Kaiser. It has the unusual ability to form circular molecules. We have measured the lengths of these λ DNA molecules in the linear and circular form, and examined the joining point by electron microscopy. Thus we have examples of unique molecules capable of circularization, and linear molecules which are circularly permuted. (auth)

Ecology

Refer also to abstract 36685.

35886 (KY-484) ENVIRONMENTAL MONITORING SUMMARY FOR THE PADUCAH PLANT FOR 1964. Baker, R. C.; Russell, A. W. (Paducah Gaseous Diffusion Plant, Ky.). July 1, 1965. Contract W-7405-eng-26. 12p. Dep(mn); $1.00(cy), 1(mn) CFSTI

Outdoor monitoring of air, water and vegetation in the vicinity of the Paducah Plant is summarized for the year of 1964. It was found that effluents from the Paducah Gaseous Diffusion Plant operations were channeled and controlled as necessary for the environmental concentrations of chemicals and radioactivity to beat acceptably low levels during the time period surveyed. (H.G.D.)

35887 (TID-21713) ONSITE ECOLOGICAL RESEARCH OF THE DIVISION OF BIOLOGY AND MEDICINE AT THE SAVANNAH RIVER ECOLOGY LABORATORY. Golley, Frank B.; Loyal, Ann H. (eds.) (Savannah River Ecology Lab., Aiken, S. C. and Georgia Univ., Athens. Inst. of Radiation Ecology). Jan. 1965. 103p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Studies of the ecosystems on the 250,000-acre reservation of the Savannah River Plant were initiated in 1952 to provide basic environmental information that would be helpful in evaluating changes that might result from the operation of the Plant. The dominant types of ecosystems were identified and an inventory was made of plant and animal species found in them, the numbers of organisms, and their weight or biomass. Successive studies of succession, productivity, and bioenergetics have been conducted. Research studies in ecology carried out since 1962 are described. Emphasis was placed on studies of the structure and functions of populations of an old-field ecosystem; the effects of γ radiation on ecological systems; and the use of radionuclides to measure ecological function in small mammals, cotton rats, and bobcat populations; and the use of phosphorus-32 to isolate food chains in intact ecosystems. (C.H.)

35888 CONTAMINATION OF VEGETATION BY RADIOACTIVE FALLOUT. Mironev, O. G. At. Energ. (USSR), 18: 659-61(June 1965).

Studies carried out in the Central European area of USSR during May, 1963 showed that 70% of the radioactivity in the examined vegetation was produced by fallout; the plant uptake was nearly 2% of all fallout radioisotope activity and 0.5% of the fallout ^{90}Sr. (R.V.J.)

35889 RELATIONSHIPS BETWEEN URANIUM AND RADIUM IN COASTAL MARINE SHELLS AND THEIR ENVIRONMENT. Blanchard, Richard L. (Public Health Service, Washington, D. C.); Oakes, Duke. J. Geophys. Res., 70: 2911-21(June 15, 1965).

Samples of seawater and bivalve molluscan shells were collected from 14 locations in the coastal waters of the United States and from one location near the Galapagos Islands oft Ecuador, South America. The seawaters were

analyzed for chlorinity, calcium, radium-226, and uranium; and the shells were analyzed for calcium, radium 226, uranium, and crystal structure. The concentration of uranium and radium in organically deposited marine calcium carbonates was found to be most strongly dependent upon the mineralogy of the carbonate, the species, and the concentration and ionic form of the nuclide in the water. The Ra/Ca ratio in the shells varied directly with the Ra/Ca ratio of the water. This correlation was especially evident when shells composed only of aragonite were considered. In the case of uranium, this correlation was less evident. Any effects due to chlorinity or mean water temperature on the ratios of U/Ca or Ra/Ca in the shells were obscured by the strong mineralogical effect. (auth)

35890 METHOD OF DETERMINING STRONTIUM-90, STABLE STRONTIUM, AND CALCIUM IN SOILS AND PLANT RESIDUES. Pavlotskaya, F. I.; Fedoseev, G. A.; Babicheva, E. V.; Zatsepina, L. N.; Tyuryukanova, E. B. Soviet Soil Sci. (English Transl.), No. 2, 197-204(Feb. 1964).

A simplified method of determining ^{90}Sr, strontium, and calcium in soils is described, in which the difficult separation of strontium from large amounts of calcium is replaced by the direct determination of strontium in the presence of calcium by flame spectrometry. The new procedure was compared to an older procedure that included the separation of strontium from calcium, by analyzing various kinds of soils for ^{90}Sr by both methods. The results agree within the experimental error of 10 to 15%. The distribution of ^{90}Sr between soil, stone, and plant fractions of the upper layer of the soil-plant cover (0 to 5 cm) is given for selected samples collected in the USSR during 1960–61. 2 tables. 3 figures. 22 references. (Pub. Health Eng. Abstr.)

35891 NEW PERSPECTIVES IN ECOLOGY. Wolfe, John N. (Atomic Energy Commission, Washington, D. C.). pp 215-18 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

For a factor that has been omnipresent in the environments of the planet since the genesis of life and through its evolution, ionizing radiation has received little scientific attention with respect to its relation to biological animals of any category. Scattered studies in space have been conducted on natural background radiation; two are in progress in the western United States at present, and one is getting under way in Brazil. However, radiation studies are developing rather abundantly in the environmental sciences in most of the major biotic provinces of the world, in marine as well as in terrestrial regimens. Noteworthy are investigations in the Pacific at Rongelap Island and in the sea itself; land and sea studies in Puerto Rico and northwest Alaska; freshwater and terrestrial researches in Lapland. Much other work of equal significance but lesser scope is being carried out. The upsurge of environmental thinking has been augmented by the presence of fallout and by associated problems, real or imagined, as well as by the development of refined instrumentation. The major efforts characterizing the new perspectives are those aligned with energy budgets of natural environments (productivity); the cycling, dispersion, and reconcentration of minerals on land and in the sea; and the intimate and essential relations of species to each other and to their respective environments, as illustrated in part by food-web patterns. While progress has been evident it has also pointed up large gaps in environmental concepts in the biosphere and at its upper and lower limits as well. Both new knowledge and ignorance have contributed to new methods, new approaches and new modes of thought that may be as striking as the new ecological perspectives introduced by Clements, Cowles, Adams, and Transeau of a half century ago. (auth)

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstracts 36652 and 36666.

35892 (NP-15082) FALLOUT IN NEW ZEALAND. Annual Summary and Quarterly Report, October–December 1964. (National Radiation Lab., Christchurch (New Zealand)). 31p. (NRL-F15) Dep.(mn).

Fallout measurements in New Zealand are reported for the fourth quarter 1964. Total gamma activity measurements on air filter samples from Auckland and Christchurch are similar to those for the third quarter. The total beta activity of Christchurch rain increased slightly from 3.1 mc/km^2 for the third quarter to 4.5 mc/km^2 for the fourth quarter. Average ^{90}Sr deposits at nine collecting stations decreased from 1.31 mc/km^2 for the third quarter 1964 to 1.16 mc/km^2 for the fourth quarter. The average annual deposition for the nine New Zealand stations was 3.6 mc/km^2 for 1964 compared with 1.8 mc/km^2 for 1963. Soil samples were collected from five New Zealand sites as part of a worldwide program for determining total accumulations of ^{90}Sr in soils. Levels of ^{90}Sr in New Zealand milk have increased steadily over the past four years. Seasonal fluctuations in milk ^{90}Sr content were noted, decreasing from July to December each year. Cesium-137 levels in milk increased from the second half of 1963 (the time at which routine measurements were first begun) through the fourth quarter 1964, average levels being 64 pC/gK and 66 pC/gK for the 3rd and 4th quarters respectively. Potential health hazards from fallout were assessed in terms of cautionary and permissible levels of ^{90}Sr in milk, since ^{90}Sr levels in the total diet differ little from those in milk. The all station average for New Zealand milk in 1964 was 8.3% of the cautionary level for the whole population and 4.2% of the permissible level for the whole population. (H.G.D.)

35893 (NYO-3234-1) BONE TISSUE KINETICS. Final Report. (Hospital for Special Surgery, New York). June 1965. Contract AT(30-1)-3234. 11p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

Studies were made on: stable calcium isotopes; direct EDTA-titration of Ca and Mg in biological samples; heavy calcium isotopes as tracers of calcium; determination of ^{46}Ca and ^{48}Ca abundance in biological samples; estimation of the exchangeable calcium pool in children using ^{48}Ca; external counting of intravenously injected ^{47}Ca or ^{85}Sr in patients with myeloma, pagent's disease, septic spondylitis, and tumors; whole-body retention of ^{47}Ca or ^{85}Sr; effect of motor denervation on muscle and bone; bone transplants in dogs; and radiation effect on the synovial membrane. (P.C.H.)

35894 (TID-21973) AN INVESTIGATION ON THE MECHANISMS AND REGULATIONS OF NUCLEIC ACID AND PROTEIN SYNTHESIS, AND THEIR POSSIBLE RELATIONSHIP TO RADIATION DAMAGE. Progress Report, September 1, 1964-August 31, 1965. Zamecnik, Paul C.; Gardella, Joseph W. (John Collins Warren Labs., Massachusetts General Hospital, Boston). Contract AT-(30-1)-2643. 45p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The various steps involved in the biosynthesis of proteins are reviewed and several aspects of the normal biosynthetic pathways are elucidated. Emphasis was placed on the relationship of the secondary structure of the transfer RNA molecule to its recognition by the enzyme involved in its acceptance of its specific amino acid. Two approaches were used: the alteration of specific bases in the transfer RNA molecule by, for example, ultraviolet irradiation; and the chemical alteration of the amino acid side chains of the enzyme, the aminoacyl-synthetase. In addition, the normal processes of growth were sufficiently delineated to make feasible investigations on the details of the regulation of protein and nucleic acid synthesis following infection by oncogenic viruses and during the process of liver regeneration. Data are included from studies on the secondary structure of s-RNA, using optical rotary dispersion; the effect of ultraviolet radiation on the formation of aminoacyl-s-RNA; the chemical modification of s-RNA; the effects of oncogenic viruses on protein and nucleic acid synthesis; and studies on growth regulation in whole cell systems. A list is included of 23 publications during the period covered by this report. (C.H.)

35895 THE ACTION OF RADIO-MIMETIC COMPOUNDS (N-YPERITES) ON PROTEIC MACROMOLECULES. Furnica, G.; Dimitriu, A. Acad. Rep. Populare Romine, Studii Cercetari Biochim., 7: 35-45(1964).

N-yperite compounds (sarcolysine and degranol) showed differing affinities towards amino acids in aqueous solution, in relation to their chemical structure. Sarcolysine appears to have a stronger affinity to threonine, and degranol to alanine. Radioprotective compounds of the AET type are bound preferably to the cysteine and leucine of the polypeptidic chain, inducing even intrapeptidic transformations, with an increased release of methionine and other amino acids. The greatest changes are undergone by the content of cysteine, taurine, threonine, arginine and methionine, released after the complete hydrolysis of protein. The intrapeptidic transformations may be considered as processes of molecular rearrangement, intrapeptidic reactions and specific labilizations of some chemical bonds in the macromolecular chain. The presence of AET in the polypeptidic chain brings about changes in the processes or interaction between proteins and N-yperites, which are specific to the N-yperite compound and which manifest themselves as a protection mechanism of the macromolecule. (Rumanian Sci. Abstr., Nat. Sci., Vol. I, No. 6, 1964)

35896 UPTAKE AND RELEASE OF VANADIUM FROM INTACT HUMAN ENAMEL FOLLOWING $V_2^{48}O_5$ APPLICATION IN VITRO. Soeremark, Rune; Andersson, Nils (Royal School of Dentistry, Stockholm). Acta Odontol. Scand., 20: 81-93(Mar. 1962).

Vanadium is isomorphous with phosphorus and can replace it in the hydroxyapatite crystals in teeth. Vanadium also seems to be incorporated into hydroxyapatite crystals during their formation in hard tissues in the same manner as some other elements, e.g., fluorine and calcium. A study was made of the uptake and release of ^{48}V from human enamel after a topical application of V_2O_5. With respect to the possible use of vanadium as a topically applied caries inhibitor, it seemed of importance to study the uptake in intact enamel and in enamel with restorations. The isotope ^{48}V is available carrier-free and has physical properties well suited for such studies. It has a half-life of 16.2 days and disintegrates by emission of positrons of 0.69 Mev and three γ rays of about 1 Mev; instead of positron emission, electron capture can take place in a small percentage of cases. The shape of the positron spectrum and the relatively hard energies of 0.69 Mev of β particles influence unfavorably the resolution of the autoradiograms. The autoradiograms showed a heavy uptake of ^{48}V in the whole tooth surface exposed to $^{48}V_2O_5$ solution. The uptake was more pronounced in the cementum than in the enamel. It appeared, with respect to the insufficient resolution in the autoradiograms obtained with the hard β rays of ^{48}V and the very thick sections, that ^{48}V was absorbed only at the enamel surface and did not seem to penetrate into the enamel even after an exposure time of 72 hr in the radioactive solution. In the root, on the other hand, ^{48}V seemed to penetrate the cementum and into the dentin. This was observed in those teeth which had been exposed to the radioactive solution for time periods of 48 hours or longer. In areas of the buccal surface of the crowns where cavities had been prepared but not filled a very heavy uptake of ^{48}V was observed in the dentin, and it penetrated the dentin into the pulp. The most pronounced loss of ^{48}V from the enamel was from surfaces immersed in a 10-ppM solution. When the enamel surfaces were washed in 10-ppM V_2O_5 solution the rate of release of ^{48}V was about the same as when they were washed in 10-ppM P_2O_5 solution. The rate of release of ^{48}V when the enamel surfaces were washed in tap water and physiologic saline solution was slow and about the same for both solutions. No significant difference in the rate of release from the buccal and lingual surfaces, or due to sex, was found. (BBB)

35897 MOUSE PLACENTAL TRANSFER OF F^{18} IN COMPARISON WITH Ca^{45}. Ericsson, Yngve; Hammarstroem, Lars (Royal Veterinary Coll., Stockholm). Acta Odontol. Scand., 22: 523-38(Nov. 1964).

Autoradiography was used to visualize the mouse placental transfer of fluoride ions, as ^{18}F, in comparison with calcium transfer, as ^{45}Ca. The ^{18}F was produced by neutron irradiation of $LiNO_3$, enriched to about 95% ^6Li, in the uranium reactor R1 of Atomenergi Company, Stockholm. The 2-step reaction produces ^3H, ^{18}F, and some contaminating activity, mainly ^{24}Na. For removal of ^3H and contaminating activity the irradiated salt was dissolved in water and calcium phosphate was precipitated in the solution. The ^{18}F was taken up almost quantitatively in the precipitate, which also included some ^3H. The precipitate was centrifuge-washed and distilled with $HClO_4$. The distillate was taken up in 0.15N NaOH and concentrated by evaporation. After neutralization to pH 5-8 the concentrate consisted of a carrier-free solution of ^{18}F of physiologically compatible ionic strength and low remaining activity of ^3H, and with no other detectable contamination. The widely diverse decay rates (half life of ^{18}F = 110 min, and of ^{45}Ca = 153 days) were utilized for the selective autoradiographic registration of the two isotopes. Placental transfer of ^{18}F as fluoride ions was visualized autoradiographically in mice up to one hour following intravenous injection of the isotope. The fetal skeleton accumulated much less ^{18}F than the maternal skeleton. Following the simultaneous ingestion of ^{18}F + ^{45}Ca an autoradiographic technique, which gives roughly similar uptake pictures for both isotopes in the maternal skeleton, produced stronger ^{45}Ca pictures of the fetal skeletons. The often occurring spotty concentrations of ^{18}F in the full-term mouse placenta were found to coincide with the concentrations of simultaneously injected ^{45}Ca, and to relate to the general areas of the degenerative placental calcifications. A quantitative study of the placental transfer in mice of simultaneously administered ^{18}F and ^{45}Ca showed a much smaller percentage of the ^{18}F dose than the ^{45}Ca dose in the fetuses up to 4 hours, in spite of a more complete absorption of ingested ^{18}F. (BBB)

35898 ACCUMULATION OF ^{137}Cs IN PLANT CROPS AS A FUNCTION OF THE PROPERTIES OF THE SOIL. Shirshova, R. A. (Soil Inst., Moscow). Agrokhimiya, No. 3, 88-95(1964).

Greenhouse experiments were conducted with buckwheat plants, grown on soils of various genetic types, characterized by different contents of exchange potassium (0.03-1.08 mg-equiv per 100 grams of soil). The entry of ^{137}Cs into the plant from the soil and its accumulation in the crop was found to be determined to a substantial degree by the content of exchange potassium in the soil. With increasing content of exchange potassium, the absorption of radiocesium by the plants was substantially reduced. The accumulation of ^{137}Cs in the crop occurred to a considerably lesser extent than that of ^{90}Sr. When the plants were grown on soils with low contents of potassium accessible for the plants, the amount of ^{137}Cs absorbed by the plants was considerable, rendering such products unsuitable for use. Supplementary applications of potassium fertilizers (in the form of phosphates and sulfates) on such soils reduced the penetration of ^{137}Cs into the plants by 10-fold or more in comparison with its content in plants grown on soils without the addition of potassium. The greatest effect of reduced absorption of radiocesium by plants was observed when both lime and potassium were applied on acid soils; the accumulation of ^{137}Cs in the crop decreased more than 20-fold in this case. (CFSTI)

35899 THYROIDAL IODINE-131 UPTAKES IN PURE-BRED BEAGLES AND CROSSBRED BEAGLE-CAIRN TERRIERS, WITH POSSIBLE GENETIC MEDIATION OF UPTAKE IN THE BEAGLES. Riddell, Patricia E.; Robinson, G. A. (Ontario Veterinary Coll., Guelph, Can.). Am. J. Vet. Res., 26: 328-31(Mar. 1965).

The Hemophiliac Dog Unit of the Ontario Veterinary College offered an opportunity to study the thyroid activity of Beagles and Beagle-Cairn Terrier crosses whose genetic and environmental factors were known. A possible genetic mediation of thyroid ^{131}I uptake, perhaps associated with a factor VII defect, was sought, using 10-μC intravenous injections of ^{131}I combined with an in vivo counting technique. The percentages of 24-hr ^{131}I uptake

by the thyroid were 15.9 ± 0.8 for purebred Beagles, 12.8 ± 0.8 for purebred Cairn Terriers, and 12.5 ± 0.6 for Beagle-Cairn crosses. Maximum concentration of radioiodide occurred between 48 and 72 hr postinjection in each group. The mean uptake for five other Beagles, 29.3 ± 1.9% at 24 hr, had not reached a max by 96 hr. These five Beagles were factor VII-deficient males, and were related: three littermates, their sire, and a brother of the sire. Genetic mediation of thyroidal ^{131}I uptake and association with the factor VII defect were considered as possibilities. (TCO)

35900 EFFECTS OF LOW IODINE INTAKE OR DESTRUCTIVE DOSES OF ^{131}I ON PITUITARY HISTOCHEMISTRY OF YOUNG CHINOOK SALMON (ONCORHYNCHUS TSHAWYTSCHA, WALBAUM). Olivereau, Madeleine; La Roche, Gilles (Institut Oceanographique, Paris). Am. Zoologist, 5: 234(May 1965).

In immature fish weighing 15-30 g the glycoprotein cells are distributed in the rostral portion of the pars distalis among erythrosinophilic follicles and corticotropic cells. The glycoprotein cells appear to represent the thyrotropic elements of the pituitary gland. As noted in rainbow trout (Salmo gairdneri), low iodine intake stimulates an increase in the number of these periodic acid-Schiff (PAS) positive cells. However, as opposed to findings in rainbow trout, six monthly intraperitoneal injections of 100 μC of ^{131}I (as carrier-free iodide) did not cause complete destruction of thyroid follicles by five weeks after the end of treatment. In a similar experiment, ^{125}I and ^{127}I studies of ^{131}I-treated immature chinook salmon confirmed the production of ^{125}I-labeled thyroxine in the absence of detectable levels of ^{127}I in the thyroid region of these fish. Pituitary histology of ^{131}I-treated chinook salmon demonstrates a stimulation of glycoprotein cells which always remains inferior to the one shown in the trout. Notably, the cytoplasm retains some of its PAS and aldehyde-fuchsin staining granulation. These histochemical differences should be further examined in the light of dissimilar radiosensitivity of the thyroid elements in two species of salmonids. (BBB)

35901 ISOTOPIC METHOD FOR MEASUREMENT OF CALCIUM ABSORPTION FROM THE GASTROINTESTINAL TRACT. Rose, G. Alan; Reed, G. W.; Smith, A. H. (General Infirmary, Leeds, Eng.). Brit. Med. J., 1: 690-2 (Mar. 13, 1965).

Results in a large series of patients using a test in which ^{47}Ca is given by mouth and the fecal radioactivity measured without further manipulation of the feces are reported. From these figures and Ca intake the Ca absorbed is calculated, and this is compared with data obtained simultaneously by the usual balance techniques. Since Ca absorption may vary from hour to hour during the day, two methods of administration were compared. In the one group the ^{47}Ca was given as a short drink during the course of breakfast; in the other group the ^{47}Ca was previously allowed to equilibrate with the entire milk ration for the day during which it was to be administered. The sensitivity of the method is such as to require ~10 μC ^{47}Ca per test. In some cases, however, the radiation measurements were done with a whole-body scintillation counter, and it was then possible to use as little as 1.5 μC. The absorption of stable Ca from the diet is taken as the product of percentage isotopic absorption and the dietary Ca. Intermittent carmine red and continuous chromium marking of stools was used. The correlation between net and true Ca absorption was greatly improved when the fecal Ca was corrected for chromium excretion. Correlation between true and net Ca absorption was much better when the ^{47}Ca was given as the single shot. The difference between true and net Ca absorption is the net secreted Ca, which seems to be virtually equal to the true secreted Ca. This secreted Ca is not raised in the metabolic conditions most commonly associated with raised fecal Ca. For many purposes this oral ^{47}Ca test could be used as an alternative to the traditional Ca balance as a means of finding net Ca absorption, although there might be occasional anomalies. Handling and chemical manipulation of stools were avoided. (BBB)

35902 DISTRIBUTION AND HALF-LIFE OF ^{131}I-LABELED PARATHYROID HORMONE IN THE RAT. Melick, Roger A.; Aurbach, G. D.; Potts, John T. Jr. (National Institutes of Health, Bethesda, Md.). Endocrinology, 77: 198-202(July 1965).

The half life and volume of distribution of radioiodinated parathyroid hormone was measured in normal and parathyroidectomized rats. The labeled hormone was detected in plasma by modified paper electrophoresis and further identified by reaction with specific antiparathyroid hormone antibody. The half life of the labeled hormone was 22.3 min in normal rats, 24.3 min in parathyroidectomized rats, and 27.6 min in parathyroidectomized rats given excess carrier parathyroid hormone. The volumes of distribution for the hormone in the 3 groups were 36.4, 27.0, and 28.6% of the body weight, respectively. The data obtained support the conclusion, derived from physiological experiments, that circulating parathyroid hormone is rapidly destroyed. (auth)

35903 EFFECT OF PHYSICAL AND BIOLOGICAL CONDITIONS ON DEPOSITION AND RETENTION OF ^{131}I ON PLANTS. Cline, J. F.; Wilson, D. O.; Hungate, F. P. (General Electric Co., Richland, Washington). Health Phys., 11: 713-17(Aug. 1965).

The loss of ^{131}I from leaf surfaces was shown to be temperature dependent in field and laboratory experiments. Leaves accumulated more ^{131}I but retained less than did soil during deposition. The effective half-lives of ^{131}I on leaves and most materials were 4 to 5 days. Mean deposition velocity was 0.5 cm/sec for plants in the field experiment. (auth)

35904 EXCRETION OF ORALLY ADMINISTERED ZINC-65 BY WILD SMALL MAMMALS. Golley, Frank B.; Wiegert, Richard G.; Walter, Robert W. (Univ. of Georgia, Athens). Health Phys., 11: 719-22(Aug. 1965).

Zinc-65 uptake and excretion by wild and laboratory small mammals differed in both the assimilation and excretion phases of the retention curves. The wild forms assimilated less of the ingested zinc and excreted the assimilated zinc at a faster rate than did the laboratory mouse and rat. The differences in rate of assimilation may be due to mode of administration; those in excretion may be a function of the differential activity or metabolism of the species under caged conditions. (auth)

35905 TWO STUDIES OF THE METABOLIC BEHAVIOR OF IODINE-131 IN THE HUMAN BODY. Boni, A. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C.). Health Phys., 11: 780-3(Aug. 1965). (DPSPU-64-30-19)

The metabolic behavior of ^{131}I in the human body was studied in two persons that had chronically ingested the isotope, one by consuming fallout-contaminated milk and the other by receiving diagnostic doses for thyroid studies. In both cases, little ^{131}I was distributed to body tissues other than the thyroid. Thus it appears that organically bound ^{131}I is distributed to other parts of the body in thyroxine only when needed. (H.G.D.)

35906 FACTORS INFLUENCING THE DISTRIBUTION OF ZINC-65 IN ALBINO RATS. Brahmanandam, S.; Nagarajan, B.; Sivaramakrishnan, V. M. (Cancer Inst., Madras). Indian J. Exptl. Biol., 3: 88-92(Apr. 1965).

The distribution of intravenously administered ^{65}Zn (as zinc chloride) in various tissues of albino rats at various intervals after injection, and the effects of various chelating agents and inert zinc carrier on the distribution of ^{65}Zn have been investigated. The tracer, injected alone, is deposited mainly in liver, bones, skin, and muscles. The excretion is comparatively slow and mainly fecal. The distribution is considerably altered by the simultaneous administration of the chelating agent, the changes being more pronounced with increasing concentration of the chelating agent; with enough chelating agent, it is possible to produce a high localization of ^{65}Zn in the lungs by oxine and 2-methyloxine (about 60 per cent) and in the liver by sodium diethyldithiocarbamate and rubeanic acid. EDTA considerably enhances the excretion of ^{65}Zn; the chelate exhibits marked apathy for liver but is preferentially deposited in skin and bones. Simultaneous adminis-

tration of carrier-zinc, with the tracer or with the tracer plus the chelating agent, delays the tissue deposition of radioactivity from the vascular compartment. While the nature of the chelating agent rather than the metal decides the specific tissue of preferential localization when a firm chelate is formed, the actual distribution is governed by quite a number of factors like the metal to chelating agent ratio and time. (auth)

35907 ACTION OF CYSTAMINE AND CYSTEAMINE ON THE OXYGEN CONSUMPTION AND THE COUPLED OXIDATIVE PHOSPHORYLATION OF RAT LIVER MITOCHONDRIA. Lelievre, P. (Universite, Liege). Intern. J. Radiation Biol., 9: 107-13(1965). (In French).

Cystamine influences the metabolism of isolated rat-liver mitochondria. Small doses of cystamine increase slightly the utilization of oxygen, whereas larger doses decrease it. The consumption of pyruvate is accelerated in the presence of low concentrations of cystamine; this effect is reversed when the concentration of the drug is increased. The phosphorylation coupled with the oxidation is slowed down whatsoever the concentration of cystamine used. This inhibition is proportionally higher than the inhibition of oxygen-consumption, so that the ratio P/O decreases regularly with increasing concentrations of cystamine. Cysteamine used in the same conditions has no effect on the metabolic activities studied. (tr-auth)

35908 THE EFFECT OF A RADIOSENSITIZER AND ITS TRITIATED ANALOGUE ON THE SULPHYDRYL LEVELS OF MOUSE ASCITES TUMOUR IN VIVO. Gronow, M. (Cambridge Univ., Eng.). Intern. J. Radiation Biol., 9: 123-32(1965).

Investigations were carried out on the effects of the radiosensitizing and antimitotic compound, 2-methyl-1, 4-naphthaquinol bis (disodium phosphate) (MNDP) and its tritiated analog on the sulfydryl (-SH) levels of two strains of mouse ascites tumor in vivo. MNDP is a water-soluble derivative of the vitamin K series. Treatment with MNDP gave a decrease in acid soluble -SH after 30 min in vivo. In this time-interval tritiated MNDP produced a much greater decrease than MNDP alone or a combination of this compound and tritiated water. No change in disulphide levels was apparent. A similar drop in the total -SH levels was found, and in some cases this was directly proportional to the dose of MNDP given. 2,3-Dimethyl-1, 4-naphthaquinol bis (disodium phosphate) and vitamin K_1 bis (disodium phosphate) gave slight increases in -SH levels, indicating that position three of the quinone ring must be free for combination with -SH groups. No change in total -SH was apparent 30 min to 1 hour after treatment of this tumor with tritiated MNDP, but a definite decrease was noticeable after 2 hours in vivo. (auth)

35909 INTERACTION OF CYSTAMINE AND CYSTAMINE DERIVATIVES WITH NUCLEIC ACIDS AND NUCLEOPROTEINS. Jellum, Egil (Univ. of Oslo). Intern. J. Radiation Biol., 9: 185-200(1965).

The disulfides, cystamine, bis (2-guanidoethyl) disulfide (GED), dimethylcystamine, tetramethylcystamine, tetraethyl cystamine, cystine dimethyl ester, and cystine diethyl ester, have been shown to interact with and become reversibly bound to calf thymus DNA, E. coli RNA, and to calf-thymus and rat-liver nucleoproteins. The interaction with the free nucleic acids resulted in a greatly enhanced thermal stability (elevated transition mid-points) of the DNA and RNA, and the reaction with the nucleoproteins resulted in a precipitation of these macromolecules. The disulfides which stabilized the nucleic acids and precipitated the nucleoproteins were typical diamines. Their association with the nucleic acids and nucleoproteins proved to be analogous to the interaction of cadaverine and spermidine with DNA. Thiols and disulfides which did not behave as di-cations had no effect. The affinity of nucleic acids for diaminodisulfides may be of consequence in the toxicity of these compounds, and possibly of importance in the radioprotective activity of certain thiols and disulfides. (auth)

35910 ACCUMULATION, DISTRIBUTION AND EXCRETION OF CALCIUM-45, STRONTIUM-90, CERIUM-144 AND CESIUM-137 IN FISH AND METHODS OF RADIOMARKING OF FISH FRY. Rudakov, N. P. Izv. Gos. Nauchn.-Issled. Inst. Ozern. i Rechn. Rybn. Khoz., 51: 165-254(1961). (In Russian)

Experiments were carried out with 5 species of fish (Cyprinus carpio L., Carassius carassius L., Salmo salar L., Salmo irideus Gibb., Coregonus autumnalis migratorius Georgi). It is shown that young fish possess a great accumulating capacity for radioactive elements dissolved in water. The accumulation rate depends upon the concentration and proportion of radioactive and stable isotopes in the solution, as well as upon duration of fish marking. Accumulation curves are of logarithmic character. Calcium-45 and strontium-90 accumulate at first in organs and tissues which come in contact with the radioactive solution (gills, scale, fins and skin). The accumulation of isotopes in bones, internal organs, and muscles proceeds slower. In 15 days both elements are almost entirely localized in bone tissue. Cerium-144 and cesium-137 accumulate in the gills in lesser quantities, than ^{45}Ca and ^{90}Sr and more rapidly enter the blood. Then ^{144}Ce concentrates in the liver and bony elements, while ^{137}Cs is distributed almost proportionally in all organs and tissues. As a result of exchange processes the radioactivity of all organs and tissues decreases quicker than the natural decay takes place. The efficiency of fish labeling with radioisotopes depends upon age and weight of the fish, on previous keeping conditions, activity of the solutions, proportion of radioactive and stable isotopes in them, pH of solutions, duration of marking and other factors. (auth)

35911 DISSIMILAR DISTRIBUTION OF CALCIUM ISOTOPES IN BLOOD SERUM AND URINE. Briscoe, Anne M.; Ragan, Charles (Columbia Univ., New York). J. Appl. Physiol., 20: 453-8(May 1965).

Data are presented to support the hypothesis that in man, an unequal distribution of ^{47}Ca exists for four or five days after its intravenous administration. This is evidenced by higher urine than serum specific activities and higher renal clearances of ^{47}Ca than of ^{45}Ca during this time interval. The disappearance of these discrepancies in renal clearance and the coincidence of the urine and serum specific activity curves follows this after about four days. It is suggested, therefore, that the early differences in distribution and excretion are due to incomplete Ca binding of the newly administered atoms rather than to the difference in their physical mass from that of stable Ca. A disproportionate amount of ^{47}Ca atoms in the diffusible serum compartment might be expected to be demonstrable by separating it from the nondiffusible fractions. Such data, obtained by dialysis of serum, are included. Separation of the diffusible from the protein-bound Ca by means of Sephadex gel filtration provides further evidence to support the hypothesis that one fraction of bound Ca does not readily exchange. The low per cent of ^{45}Ca associated with the protein fractions is compatible with the observation that Sephadex disrupts all but the most stable complexes of proteins and metal ions. This might include the newly administered ^{47}Ca since little or none was detectable in the protein-containing fractions. (TCO)

35912 THE EFFECT OF POTASSIUM CONCENTRATION ON Ca^{45} UPTAKE IN FROG SARTORIUS MUSCLE. Weiss, George B.; Bianchi, C. P. (Univ. of Pennsylvania, Philadelphia). J. Cellular Comp. Physiol., 65: 385-92 (June 1965).

Radiocalcium uptake by frog sartorius muscle is increased as the potassium concentration of the bathing Ringer is increased from 1.6 mM to 32.0 mM; at higher concentrations of K^+ no further increase in radiocalcium uptake occurs. Substitution of the chloride of Ringer solution by nitrate increases the amount of radiocalcium uptake at potassium concentrations between 1.6 and 32.0 mM but not at higher concentrations. The nitrate anion enhances both the maximum tension and the area of the contracture curves that occur between 16 and 80 mM K^+. Comparison of paired muscle preparations in nitrate Ringer at 32 mM K^+ and 80 mM K^+ shows no difference in total radiocalcium uptake and no difference in the area under the contracture

curves. When a three minute pre-equilibration period in ^{45}Ca is omitted, the radiocalcium uptake by the sartorius muscle in 80 mM K^+, ^{45}Ca Ringer nitrate is reduced by 50% as compared to its mated muscle soaked in 32 mM K^+, ^{45}Ca Ringer nitrate. Within the limitations of the experimental techniques employed, it appears that calcium uptake is more prolonged at lower levels of potassium (32.0 mM) but the total amount taken up is the same as at higher levels of potassium (80 mM). (auth)

35913 A COMPARISON OF PROCEDURES FOR MARKING ADULT ENDOPARASITIC WASPS WITH ^{32}P. Rahalkar, G. W.; Doutt, R. L. (Univ. of California, Berkeley). J. Econ. Entomol., 58: 278-81(Apr. 1965).

Two methods of labeling adults of Phanerotoma flavitestacea (Hymenoptera: Braconidae) with ^{32}P were compared. This parasite was imported to aid in the control of the navel orangeworm, Paramyelois transitella. When adults of P. flavitestacea were allowed to feed on 0.01 ml of honey contaminated with ^{32}P (0.1 to 0.3 mC/ml), they readily acquired radioactivity. In the 1-μC treatment immediately after feeding, 75% of the individuals showed 1000 to 3000 cpm. In the 3 μC treatment, none of the individuals was below 2000 cpm and some ranged up to 10,000 cpm and higher. Longevity was not seriously affected by the ingestion of radiophosphorus; at the end of 43 days 40% of the adults were still surviving. Since the radioactivity retained by the adults was detectable for 24 to 36 days, their longevity thereafter is not of much significance. Radiophosphorus was lost from the insect body primarily through excretion while loss through oviposition was comparatively much less. Parasitized host eggs showed detectable amounts of radioactivity even on the 10th day of oviposition. When the parasites developed in hosts feeding on radioactive food (treated with 0.5, 1.0, or 2.0 mC/30g), the adult parasite emergence was adversely affected and the severity of this effect increased with dose. Adult emergence was 52.7, 28.4, and 3.3% in the 0.5-, 1.0-, and 2.0-mC treatment groups, respectively, as compared with 98.3% emergence in the controls. Furthermore, the radioactivity acquired by the adults in these treatments was very low and considerably lower than that acquired when ^{32}P was provided through honey. However, elimination from the body was not rapid in these individuals, with th result that even at the end of 14 days there was detectable radioactivity in the adults. It appears that feeding adults of P. flavitestacea honey contaminated with ^{32}P is an efficient method of marking this endoparasite without any seriously adverse effects on its behavior and longevity. The best dosage as indicated by these experiments is 2 μC of ^{32}P per adult through 0.01 ml of honey. (BBB)

35914 THE EFFECT OF GROWTH HORMONE AND PROLACTIN PREPARATIONS ON THE CONTROL BY INTERSTITIAL CELL-STIMULATING HORMONE OF UPTAKE OF ^{65}Zn BY THE RAT DORSOLATERAL PROSTATE. Gunn, S. A.; Gould, Thelma C.; Anderson, W. A. D. (Univ. of Miami, Fla). J. Endocrinol., 32: 205-14(May 1965).

The pituitary hormones, follicle-stimulating hormone (FSH), adrenocorticotrophic hormone (ACTH), thyroid-stimulating hormone (TSH), growth hormone, and prolactin, were tested for their capacity to alter the control by interstitial cell-stimulating hormone (ICSH) of the uptake of ^{65}Zn by the dorsolateral prostate gland of the mature hypophysectomized Sprague-Dawley rat. On the 4th day of treatment, the 8th day after hypophysectomy, each rat received subcutaneously 0.5 μC of ^{65}Zn. Only prolactin and growth hormone produced significant augmentation of the response to ICSH. Contamination with growth hormone was apparently not responsible for the augmentation of ICSH activity brought about by the prolactin preparation used. This prolactin and another highly purified preparation were equally effective in their capacity to augment the ^{65}Zn-uptake response produced by ICSH. Augmentation was detectable with total doses of prolactin as low as 10 to 30 μg (0.21 to 0.63 IU). Prolactin caused an augmentation of testosterone activity on uptake of ^{65}Zn in the hypophysectomized and castrated rat, indicating an effect of prolactin on the prostate that is not mediated by the testis. Growth hormone was not as effective as the prolactin preparations in enhancing ICSH activity, but in sufficient doses produced a significant increase in the ^{65}Zn of the dorsolateral prostate was a more sensitive and more consistent parameter than glandular weight for the detection of augmentation of ICSH response by growth hormone or prolactin preparations. The ^{65}Zn-uptake method offers a very sensitive procedure for detecting prolactin. There has been considerable controversy recently as to whether prolactin and growth hormone are separate entities. Since a highly purified prolactin was shown to be efficient in its capacity to augment ICSH activity, and growth hormone, in sufficient doses also evoked an augmentation of ICSH activity, this study demonstrated another biology response that prolactin and growth hormone have in common. (BBB)

35915 EFFECTS OF COPPER, MOLYBDENUM, AND ZINC ON ZINC-65 TISSUE DISTRIBUTION AND EXCRETION IN THE RAT. Kinnamon, Kenneth E.; Bunce, George E. (Fitzsimons General Hospital, Denver). J. Nutr., 86: 225-30(July 1965).

Sprague-Dawley rats, weighing initially 104 to 143 g, were given a 5 μC intraperitoneal injection of aqueous $^{65}ZnCl_2$ solution containing 350 μg of zinc/ml with 1380 μC/mg sp act. The rats were then placed in metabolism cages and urine and feces were collected daily until the animals were killed 4 days later. One or more of the following ingredients was added to this basal diet: 100 mg/kg copper as $CuSO_4 \cdot 5H_2O$; 800 mg/kg molybdenum as $Na_2Mo_4 \cdot 2H_2O$; and 5000 mg/kg zinc as $ZnCO_3$. These levels of supplementation were utilized to obtain the following eight treatments: basal ration (control); Cu; Mo; Zn; Cu + Mo; Cu + Zn; Mo + Zn; and Cu + Mo + Zn. Body weight decreased in both male and female rats fed the diet with excess Cu + Mo + Zn and in the male rats fed the high Mo + Zn diet. Within any treatment group, greatest activity of ^{65}Zn was observed in liver and spleen, with pancreas, kidney, lung, and bone slightly less active. Least activity was observed in skeletal muscle and brain. The activities of heart and testes were intermediate. Elevation in dietary Zn resulted in a decreased retention of the injected ^{65}Zn in soft tissue in almost every instance regardless of the level of Cu or Mo. Retention in bone, however, was significantly increased, in both male and female rats when the high Zn diet alone was fed; this effect was intensified in the males and reduced in the females by supplements of Cu and/or Mo. No significant differences in fecal elimination of ^{65}Zn were demonstrated among the treatment groups. Fecal excretion is the chief means of radiozinc elimination, presumably via pancreatic secretion. Urinary ^{65}Zn excretion was increased in all animals maintained with an elevated Zn ration, except in females of the Cu + Mo + Zn treatment. (BBB)

35916 PHARMACOLOGY AND TOXICOLOGY OF THE RARE EARTH ELEMENTS. Haley, Thomas J. (Univ. of California, Los Angeles). J. Pharm. Sci., 54: 663-70 (May 1965).

This review considers the acute and chronic toxicity, biochemistry, metabolism, pharcodynamic effects, and clinical applications of the following elements: Sc, Y, La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu. A table gives the acute lethal doses of the chlorides of these rare earths elements. With increasing industrial usage, it has become necessary to obtain more and detailed information on the toxicology and pharmacology of the rare earth elements to forestall any possible deleterious effects occasioned by their use. Upon the basis of toxicity classification, these elements can be considered only slightly toxic. The symptoms of acute toxicity for all of these elements include writhing, ataxia, labored respiration, walking on the toes with arched back, and sedation. There is a delayed lethality with the peak death rate not occurring for 48 to 96 hr. There is also a sex difference, with the female being more susceptible than the male. In animals surviving 30 days, there is generalized peritonitis, adhesions, hemorrhagic ascitic fluid, granulomatous peritonitis, and focal

hepatic necrosis. The use of citrate or other chelation agents obscures the lethal effects of these elements by either decreasing the rate of release of the element or by increasing the lethability through removal of another essential element, such as Ca. The transition elements (Tb group) appear to be less toxic than those above or below them in the periodic table. Their low oral toxicity is related to poor intestinal absorption. Inhalation of rare earth fluorides or oxides results in progressive lung retention, but no pneumoconiotic fibrosis is observed. Human exposure to vapors of rare earths caused sensitivity to heat, itching, and a sharper sense of odor and taste. The most prominent biochemical effect of injected rare earths is the production of a fatty liver, but this is not seen after oral administration and occurs only with the elements La through Sm. Pharmacologic effects on the eye, skin, and muscle (striated, smooth, and cardiac) are described, as are the generalized pharmacologic reactions to the rare earths. Clinical applications described include mainly the use of the radionuclides for radiotherapy. 96 references. (BBB)

35917 THE EFFECTS OF ALKALINE EARTHS AND OTHER DIVALENT CATIONS ON ADRENAL MEDULLARY SECRETION. Douglas, W. W.; Rubin, R. P. (Albert Einstein Coll. of Medicine, Bronx, N. Y.). J. Physiol. (London), 175: 231-41(Dec. 1964).

Strontium and Ba were found to resemble Ca, in in vivo experiments with cat adrenals, in that each stimulated catecholamine secretion when introduced during perfusion with Ca-free Locke's solution and restored the responses acetylcholine (ACh) and excess K otherwise absent in this medium. These ions can substitute for Ca in the secretory process. There was little, if any, change in catecholamine secretion when adrenal perfusion was switched from Locke's solution to Sr-substituted Locke's solution (i.e., Ca-free Locke's solution with the addition of 2 mM Sr). Even after prolonged perfusion with this solution, the reintroduction of the normal amount of Ca (2.2 mM) failed to evoke secretion. It was also noted that Sr (4 to 8 mM) had little effect on secretion when given during perfusion with Locke's solution or Sr-substituted Locke's solution, but did provoke secretion when the adrenal was perfused with high-K Locke's solution and, moreover, that this effect increased with increasing concentrations of Sr. Barium differed from Sr and Ca in that it stimulated catecholamine secretion when introduced during perfusion with Locke's solution (i.e., without prior Ca deprivation). A variety of other divalent cations, including Mg, were without stimulant effect on catecholamine secretion and failed to restore responses to ACh or K when added during perfusion with Ca-free Locke's solution. The unknown Ca-dependent process involved in the release of the hormones from the adrenal medulla thus appears to be one which can be activated by Ca, Sr, and Ba but not by other divalent cations, including the closely related alkaline earth Mg (which has powerful inhibitory effects). As knowledge of the effect of ions on the adrenal medulla and posterior pituitary gland has accumulated, it has become clear that their influence on stimulus-secretion coupling in these organs is similar to their effects in excitation-contraction coupling in muscle. (TCO)

35918 THE SPACE ACCESSIBLE TO ALBUMIN WITH THE STRIATED MUSCLE FIBRE OF THE TOAD. Hill, D. K. (Postgraduate Medical School, London). J. Physiol. (London), 175: 275-94(Dec. 1964).

Autoradiography was used to demonstrate the penetration of ^3H-labeled albumin in muscle. Two methods of ^3H-labeling albumin are described in detail, and an evaluation of the radiation damage to muscle from ^3H-albumin was made. The muscles were exposed to the radioactive solution at 0°C; muscle is much less susceptible to radiation damage at 0° than it is at 20°C. It is likely that at the higher temperature a muscle exposed at 30,900 μC/ml would have become seriously damaged. Crystallized bovine plasma albumin was labeled with ^3H by two methods: catalytic gas exposure; and acetylation with tritiated acetic anhydride. When sartorius muscles of the toad (Bufo bufo) were soaked in a solution containing ^3H-albumin, and fixed with osmium tetroxide or by freeze-drying, autoradiographs showed that a small amount of albumin had penetrated into the fibers. The space accessible to these molecules was estimated as 0.12-0.28% of the fiber volume. About half the albumin space (0.10% of the fiber volume) was at the position of the Z line and the remainder in a pair of spaces (each being 0.05% of the fiber volume) at the ends of the A band, close to the A-I boundary. Whether the space at the A-I boundary is an artifact due to radiation damage is discussed. There was considerable variation between fibers in the volume of the albumin space, and it is suggested that some of this variability might be attributed to radiation damage. (TCO)

35919 THE EFFECT OF INSULIN ON IODINE METABOLISM OF FETAL RAT THYROID GLANDS IN ORGAN CULTURE. Nataf, B. M.; Chaikoff, I. L. (Univ. of California, Berkeley). Life Sci., 3: 895-8(1964).

The action of insulin on ^{131}I uptake and incorporation of ^{131}I into various thyroid hormones and precursors was studied in vitro. This study demonstrated that insulin has a direct and pronounced effect on thyroid tissue. The addition of insulin to a medium in which embryonic thyroid glands were cultured enhanced the incorporation of ^{131}I into protein-bound moniodotyrosine (MIT), diiodotyrosine (DIT), and thyroxine (T_4). Rat fetal thyroid glands were explanted, and exactly 24 hr before the end of 4-day cultures, 50 μl of the 199 nutrient solution containing 10 μC (10^7 cpm) of carrier-free ^{131}I was added. Total ^{131}I uptakes, protein-bound iodine ($PB^{131}I$), and protein-bound ^{131}I-amino acids were determined in homogenates. The 24-hr ^{131}I uptakes by the explants cultured in basal medium ranged from 0.1 to 0.3% of the added ^{131}I per whole thyroid gland (about one mg). The ^{131}I uptake per one thyroid gland was 0.18%. Chromatographic analysis of the hydrolyzed homogenate showed that the ^{131}I-amino acids formed were mostly MIT and DIT. The value for the MIT/DIT ratio was ~4. The amount of labeled T_4 formed was very low. The ^{131}I uptakes by thyroid tissue in a medium to which insulin had been added rose considerably: from 0.7 to 1.2% of the added ^{131}I was recovered per whole embryonic thyroid gland. In a typical experiment the 24-hr ^{131}I uptake was 0.8% per whole thyroid explant, about 90% of which was protein-bound. The addition of insulin resulted in a significant increase in the amounts formed of labeled MIT, DIT, and T_4. The values for the MIT/DIT ratio decreased from about 4.0 in control experiments, to values of 2.5 in the presence of insulin. Thus, the addition of insulin to the organ culture medium greatly improved the ^{131}I utilization by embryonic thyroid tissue. (BBB)

35920 THE EFFECT OF DEUTERIUM OXIDE ON THE GROWTH OF PEPPERMINT (MENTHA PIPERITA L.). III. EFFECT OF CERTAIN GROWTH REGULATORS. Blake, M. I.; Crane, F. A.; Uphaus, R. A.; Katz, J. J. (Univ. of Illinois, Chicago). Lloydia, 27: 254-63(Sept. 1964).

Substitution of D_2O for water in the nutrient solution had a marked inhibitory effect on the growth responses of mint plants. The effects of the interaction of D_2O with the stimulatory or inhibitory effects of certain growth regulators (indoleacetic acid, naphthaleneacetic acid, and gibberellic acid) were studied. A fourth agent used was maleic hydrazide which is a growth inhibitor when applied to plants growing in an aqueous medium. Responses of peppermint plants to the growth regulators were studied, as well as the influence of D_2O on their effects. Gibberellic acid successfully stimulated stem elongation at the 30 and 50% D_2O levels. This effect was similar to that observed in control plants, but to a lesser extent. At the 70% D_2O level there was an immediate increase in stem length lasting 14 days, resulting from a stimulation in the elongation of the apical stem cells. This was accompanied by increased anabolic activity. As a result, the metabolic processes within the living cells could not keep pace with the strained, stimulated shoots, and the plant succumbed. Naphthaleneacetic acid which stimulated shoot elongation in the control plants was completely ineffective in the plants grown in 30 and 50% D_2O; growth was inhibited to a greater extent than that

attributable to the D_2O in the nutrient. This was reflected in the lower solvent uptake compared to the controls. An explanation for this reversal in the expected effect is not apparent. This effect was not observed at the 70% D_2O level, where the naphthaleneacetic acid-treated plant did significantly better than the control. No unusual effects were observed with the indoleacetic acid-treated plants, which did as well as or better than the corresponding control plants at all levels of deuteriation. Thus it appears that the more potent growth stimulator has the greater toxicity in the deuteriated plant (70% D_2O) and that indoleacetic acid and naphthaleneacetic acid, which are less potent growth stimulators than gibberellic acid, have a distinctly less toxic effect on the deuteriated plant. The most significant observation was that low concentrations of maleic hydrazide stimulate rather than inhibit growth in high concentrations of D_2O. (TCO)

35921 THE INTRODUCTION OF RADIOACTIVE COLLOIDAL SOLUTIONS OF Au^{198}, P^{32}, Ag^{111} INTO LYMPHATIC VESSELS. Tarasov, N. F. Med. Radiol., 10: No. 5, 61-5(May 1965). (In Russian)

A comparative study was made of the distribution of radioactive colloidal solutions of ^{198}Au, ^{32}P and ^{111}Ag in the superficial lymphatic vessels of dogs and rabbits. The results show that colloidal radiogold is suitable for this method of radiotherapy of lymph nodes. After the administering of ^{32}P and ^{111}Ag solutions, a significant irradiation of all organs and tissues occurred. It was concluded that radiocolloids are unsuitable for lymphatic therapy. (TCO)

35922 INDIRECT DETERMINATION OF THE CONTENT OF ^{137}Cs IN THE HUMAN ORGANISM. Ramzaev, P. V.; Shamov, V. P.; Troitskaya, M. N.; Lebedev, O. V.; Ibatullin, M. S. (Scientific-Research Inst. of Radiation Protection, Leningrad). Med. Radiol., 10: No. 6, 22-8 (June 1965). (In Russian)

The relation between the content of ^{137}Cs in the body and its excretion was established on the basis of studies of 25 healthy men whose work did not involve radioactive material. The ratios of body specific activity to specific activity in urine and in feces were measured. The biological half life of ^{137}Cs was found to be 115 ± 72 days. The minimum measurement error, determined by individual variations from the mean, was ±60%; the error can extend to as much as 100%, depending on the practical lengths of time for collecting the excretion. An exponential model, giving body content of ^{137}Cs in terms of biological half life and content in the feces and urine, was used in the calculations. (M.J.T.)

35923 DEPOSITION OF STRONTIUM AND CALCIUM IN SNAIL SHELL. Rosenthal, G. M. Jr.; Nelson, D. J.; Gardiner, D. A. (Oak Ridge National Lab., Tenn.). Nature, 206: 51-4(July 3, 1965). (ORNL-P-608)

The relative effects of strontium and calcium concentrations in the environment on their uptake and incorporation into snail shell were investigated. ^{45}Ca and ^{85}Sr were used as tracers and specific activities were used to determine deposition. Data are presented in tables and graphs. Deposition of both calcium and strontium in the snail shell depended primarily on the respective concentrations of these elements in the immediate environment. A slight effect of strontium on calcium deposition was observed. There was found to be a minimum strontium deposition for various combinations of strontium and calcium in the environment. It was concluded that strontium uptake is more closely associated with environmental strontium concentrations than with calcium concentrations. (M.C.G.)

35924 THE EFFECT OF DIETHYLENE-TRIAMINE-PENTAACETIC ACID ON EXCRETION ENHANCEMENT OF INTRATRACHEALLY INJECTED RADIOYTTRIUM. Trnovec, Tomas; Beno, Milan; Pleskova, Anna; Vladar, Milan. Pracovni Lekar., 17: 135-9(May 1965). (In Czech)

The effect of diethylenetriaminepentaacetic acid (DTPA) on radioyttrium excretion in rats following an intratracheal injection of 12 μC carrierfree $^{91}YCl_3$ solution was studied. The experimental group was treated by 5 intraperitoneal injections of 100 μM DTPA in two-day intervals starting on the second and the 15th day respectively, and organ activity analyses in the experimental and control animals were carried out on the 14th and 28th day respectively. In both cases an increased urinary excretion of radioyttrium was observed. The overall urinary ^{91}Y was 3.7 times higher when DTPA administration was started early and 1.95 times higher when administered later, as compared with data of the control groups. The fecal excretion of radioyttrium remained practically unchanged. A considerable decrease of organ activities was achieved. (tr-auth)

35925 INCORPORATION OF PHOSPHORUS-32 AND SELENIUM-75 IN COCK SPERM. Patrick, H.; Voitle, R. A.; Hyre, H. M.; Martin, W. G. (West Virginia Univ., Morgantown). Poultry Sci., 44: 587-91(Mar. 1965).

Since DNA is the genetic substance of a reproductive cell, it would be useful to know when the spermatogonia increase in number because this should be a desirable time to treat cocks with chemicals or γ irradiation if the greatest possible amount of genetic changes are desired. Also, the time when spermatocytes begin their progressive decrease in cytoplasm content would be of value in establishing nutrition effects. More genetic changes should be possible if treatment of the spermatogonia occurs when rapidly multiplying. New Hampshire cocks were given 200 μC ^{32}P subcutaneously and the semen collected every two days for 42 days following radionuclide administration. DNA was isolated from the sperm and the ^{32}P content assayed. Similar cocks were each given 100 μC of ^{75}Se subcutaneously and sperm collected and fractionated as in the ^{32}P experiment. The reproductive tract was also removed, ^{75}Se content determined, and tested for selenomethionine and selenocystine. The cocks incorporated ^{32}P into the DNA and the protein of sperm. The ^{32}P in the DNA was firmly bound and radionuclide determinations demonstrated that the most active stage of DNA synthesis occurs about 26 days before the sperm is ready for collection. Most of the phosphoprotein is formed about 16 days before the sperm is ready for collection. Studies with ^{75}Se showed that the reproductive system can metabolize and retain Se for sperm formation. Also the Se is in the protein fraction and appeared in the cystic acid position in chromatographic studies. This probably means that it is replacing S in the S amino acids synthesized by the testes. The incorporation of ^{75}Se into the sperm protein for a period of over 48 days after isotope administration and concentration of ^{75}Se in the reproductive tract demonstrate that the cock's reproductive system retains the Se for sperm formation in a form which is firmly bound and also suggest that a Se pool exists which metabolically is different from that of S. Attempts to isolate ^{75}Se from chondroitin and bile taurine were not successful. (BBB)

35926 ON DISTRIBUTION OF ^{22}Na IN A RESERVOIR. Nefedova, A. I.; Popova, E. I. (Inst. of Biological Physics, Moscow and Inst. of Biology, Academy of Sciences, Syktyvkar USSR). Radiobiologiya, 5: 451-6 (1965). (In Russian)

The distribution of ^{22}Na introduced into a model reservoir was similar to that found for cesium. It was 80% in solution, the rest being partly in the hydrobiotites and partly in the soil. The plant content varied as much as a factor of 10 with the species. The mollusk content differed less among species, but the body always had much more than the shell. (tr-auth)

35927 COEFFICIENTS OF ^{90}Sr ACCUMULATION BY FRESH-WATER PLANTS FROM SOLUTIONS OF DIFFERENT SPECIFIC ACTIVITY. Timofeeva, N. A.; Agre, A. L. (Inst. of Biology, Academy of Sciences, Sverdlovsk USSR). Radiobiologiya, 5: 457-8(1965). (In Russian)

A variation of four orders of magnitude in the ^{90}Sr specific activity of the water medium around fresh water plants did not affect the accumulation of ^{90}Sr by the individual plant. (tr-auth)

35928 THE INTERPRETATION OF AUTORADIOGRAMS, ESPECIALLY WHEN USING TRITIUM AS A

TRACER. Levi, Hilde (Univ. of Copenhagen). Scand. J. Haematol., 1: 138-49(1964).

Limitations of the autoradiographic method and the interpretation of autoradiograms, especially when using tritium as a tracer, are discussed. When using ^{3}H as a tracer, both the histological and the autoradiographic technique must be perfected to a much higher degree than is necessary with any other tracer. The autoradiogram may give a distorted picture of ^{3}H localization and the quantity of the labeled compound in the tissue. Establishment of the presence or absence of the label in the cell by autoradiography is concerned with histological detail, and with the physical limitations inherent in the radiation properties of this tracer. Some of the principal limitations of relative quantitation and, hence, the interpretation of ^{3}H autoradiograms are discussed. Some of the difficulties are encountered with all β emitters, some particularly when ^{3}H β rays are used, because their energies are only a few kev, and their ability to penetrate matter is only a fraction of a micron. Whether or not a cell is labeled rests on statistical evaluation of background measurements and the difference between background and effect. The problem of comparison of the quantities of labeled substance in different objects such as single cells is examined. Also considered is the evaluation of the blackening produced by objects of different sizes, where constancy of the ratio surface/volume cannot be taken for granted. This difficulty is avoided when ^{14}C or other isotopes with similar radiation properties are used as tracers, by expressing the counting results in terms of grains per cell. Such a short-cut is permissible if self-absorption of the β rays in the object proper is negligible. The relation between particle energy and number of grains produced is examined in terms of the distribution of grains in space around a point source and the grain spacing within tracks as a function of particle energy. Data are provided on ^{14}C and ^{3}H. The number of grains produced in the emulsion depends not only on the amount of label present, but on the thickness of the object and its distance from the emulsion. In other words, the number of grains observed is not necessarily a measure of the amount of label present in the object. The autoradiogram of ^{3}H-labeled tissue section depicts only the average labeling in the top of 1 or 2μ of the sample. With ^{14}C an increase in emulsion thickness up to 25μ will increase the proportionality range between number of incident particles and blackening obtained (although resolution will decrease and background increase). In the case of ^{3}H, an increase in emulsion thickness beyond one μ does not widen the proportionality range, but it does increase the background. These basic facts cannot be altered by moderate improvement in autoradiographic technique. It is therefore important to realize that there are some questions which autoradiography cannot answer. A decision improvement can only be achieved by the introduction of an emulsion with a much smaller grain. (BBB)

35929 CYCASIN: RADIOMIMETIC EFFECT. Teas, Howard J.; Sax, Hally J.; Sax, Karl (Univ. of Georgia, Athens). Science, 149: 541-2(July 30, 1965).

Cycasin, methylazoxy-methanol-β-glucoside, a carcinogenic compound that occurs naturally in cycad plants, induced chromosome aberrations in the root-tip cells of Allium cepa. Germination and growth in an aqueous solution of cycasin at a concentration of only 3% of that found in Cycas circinalis induced as many aberrations in chromosomes as did about 200 R of gamma irradiation. (auth)

35930 POLONII. MATERIALY PO TOKSIKOLOGII, KLINIKE I TERAPII PORAZHENII. (Polonium. Data on the Toxicology, Clinical Studies, and Therapy). Sanotskii, V. A. Moscow, Izdatel'stvo "Meditsina," 1964. 275p.

Twenty-nine articles are presented on Po toxicology and clinical therapy. Experimental data is included on: Po intoxication pathology; effects of Po on metabolism, the nervous system, blood, kidneys, and thyroid glands, and pathomorphological injuries. Other experiments on clinical therapy are discussed including investigations involving blood transfusions, antibiotics, and hematotic stimulants. Extensive references are given. (R.V.J.)

35931 THE METABOLIC PATTERN OF MAMMALIAN CELLS INFECTED WITH POLIOVIRUS. Contreras, Guillermo; Fischer, Siegmund; Grado, Carmen; Ohlbaum, Adela (Universidad de Chile, Santiago). pp 41-5 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

Kinetic studies showed that the inhibitory effect of chloramphenicol over poliovirus multiplication on human cells is observed only when the antibiotic is added within 10 min before to 10 min after viral infection, whereas, when added 20 min after infection, no inhibition was observed. We have previously observed marked changes in the nucleic acids isolated from this system using ^{32}P as the label and have been able to reproduce these observations when highly polymerized DNA and RNA were obtained. In an effort to investigate the mechanism by which RNA viruses transmit their genetical information further characterization of the DNA extracted from HEp2 cells infected with poliovirus was undertaken. The results indicate that DNA from infected cells has marked alterations of the OD 250/260 ratio; showed a component of higher molecular weight when submitted to ultracentrifugation in a linear sucrose gradient, and has a different thermal denaturation profile when compared with DNA extracted from noninfected cells. RNA isolated from infected and noninfected cells also showed different patterns, when submitted to ultracentrifugation in a linear sucrose gradient. (auth)

35932 STUDIES ON THE ACTIVATING ENZYMES OF AMINO ACIDS. Allende, Jorge E.; Allende, Catherine C.; Coronado, Alfonso; Mardones, Elvira; Gatica, Marta; Celis, Julio; Matamala, Maria (Universidad de Chile, Santiago). pp 47-53 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

The activating enzymes catalyze the reaction of incorporation of amino acids into specific soluble ribonucleic acids. This reaction is the first stage of the complex and an important process in protein biosynthesis. The authors' studies were directed toward establishing the structural bases of the specificity demonstrated by these enzymes. Attention was centered on the activating enzymes of arginine, threonine, and proline. The activity of these enzymes is measured by the incorporation of carbon-14-labeled amino acids in soluble ribonucleic acid. The activating enzyme of arginine, taken from rat liver, was purified 280 times. Of various compounds analogous to arginine that have been tested as inhibitors of the reaction, only canavanine showed inhibitory ability. This compound, canavanine, serves as a substrate for the enzyme and is incorporated into soluble ribonucleic acid as well as into proteins in an in vitro system. The activating enzyme of threonine, taken from pig liver, and the activating enzyme of proline from the chicken embryo, have been partially purified. (auth)

35933 FORMATE METABOLISM IN THE YEAST SACCHAROMYCES CEREVISIAE. de Boiso, Julia F.; Stoppani, A. O. M. (Universidad de Buenos Aires and Comision Nacional de Energia Atomica, Buenos Aires). pp 55-7 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

Formate-^{14}C is incorporated by the yeast Saccharomyces cerevisiae, and serine in the first condensation product within the cell. The amino acid radioactivity which is high at the beginning of incubation, is followed by a decline with a consequent increase in the labeling of glutamic acid. The fixation is done directly, without previous transformation of the formate into carbon dioxide. The serine-^{14}C contains the highest percentage of fixed radioactivity, and no labeling is observed in glycine. Formate-^{14}C condenses with glycine to give serine-3-^{14}C; glycine originates in the glyoxylate transamination produced by cleavage of isocitric acid, which explains the difference in incorporation in the presence or absence of glucose, a substance that generates glycine. The fixation of formate and the serine synthesis

are inhibited by azide, hydroxylamine, and fluoride; dinitrophenol and antimycin A have a similar effect in the presence of glucose. Actidione does not inhibit the serine synthesis but hinders its incorporation into proteins. (auth)

35934 EFFECT OF DNP ON THE METABOLISM OF PHOSPHATES IN SACCHAROMYCES CEREVISIAE. Stoppani, A. O. M.; Bennun, A.; de Pahn, Esther M. (Universidad de Buenos Aires and Comision Nacional de Energia Atomica, Buenos Aires). pp 59-68 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

The yeast Saccharomyces cerevisiae incorporates phosphate (^{32}P) during glucose, acetaldehyde, acetate, and pyruvate oxidation. Labile phosphate compounds attain the greatest specific activity. The incorporation of phosphate-^{32}P is inhibited by 2 : 4-dinitrophenol (DNP) and antimycin A; the inhibition is partial with glucose and endogenous substrates. DNP inhibits phosphorylation associated with the oxidation of glucose, acetate, acetaldehyde, pyruvate, and butanol, but the phosphorylation associated with glycolysis partially resists the effect of DNP and antimycin A. DNP strengthens the inhibition of phosphorylation by antimycin A. Glucose antagonizes the effect of DNP on acetate oxidation; a high intracellular level of polyphosphates prevents the inhibition of acetate oxidation and coupled phosphorylation by DNP. In the presence of antimycin A or DNP, or anaerobically, glucose stimulates acetate-1-^{14}C oxidation. (auth)

35935 USE OF ^{32}P-LABELED NUCLEOTIDES IN THE STUDY OF THE KINETICS OF POTATO APYRASE. Traverso-Cori, Aida; Chaimovich, Hernan; Cori, Osvaldo (Universidad de Chile, Santiago). pp 69-74 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

Adenosine diphosphate labeled with ^{32}P in the β position and adenosine triphosphate labeled either in the β or in the γ position were prepared using biosynthetic procedures. These nucleotides were used for a study of the reaction mechanism of potato apyrase, which splits both the β and the γ phosphate from adenosine triphosphate and the terminal phosphate from adenosine diphosphate. The enzyme used was prepared by a yet-unpublished procedure, and shows a specific activity of 200 μmoles of phosphate split per minute and per milligram of protein at 30°C and pH 6, in the presence of Ca ions. This preparation carries out predominantly the splitting of the gamma phosphate of adenosine triphosphate before attacking the adenosine diphosphate formed. The evidence rests on the measurement of the specific activity of the liberated inorganic phosphate, using either γ- or β-labeled adenosine triphosphate. The mechanism of this reaction may be due to a competitive inhibition of the splitting of adenosine diphosphate by the enzyme-bound adenosine triphosphate. The fact that unlabeled adenosine triphosphate inhibits liberation of radioactivity from β-labeled adenosine diphosphate, with unchanged maximum velocity and changed Michaelis constants, supports this interpretation. The results are discussed in terms of the binding of adenosine diphosphate and adenosine triphosphate on the apyrase molecule. (auth)

35936 GALACTOSE TRANSPORT SYSTEM IN SACCHAROMYCES CHEVALIERI. Schwencke, Jaime (Universidad de Chile, Valparaiso). pp 75-80 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

Galactose has been shown to concentrate in Saccharomyces chevalieri cells through an inducible system. The activity of the transport system is temperature-dependent. The uptake of galactose is blocked 90% by 10^{-2} M sodium azide, and 70% by 2.5×10^{-3} M 2.4 dinitrophenol, thus indicating a dependence of activity on an energy generating system. The internally accumulated carbohydrate is at least 50% galactose, as indicated by the displacement of accumulated galactose ^{14}C by cold galactose. In paper chromatography other compounds are also detectable. L-arabinose ^{14}C, thiogalactose ^{14}C, beta-methylgalactoside ^{14}C are not accumulated by the cells, indicating that the transport system is specific for galactose. The galactose ^{14}C internally accumulated is not readily washed out either by cold distilled water or cold KH_2PO_4 M/15, pH 5.5 buffer, but it exchanges readily with externally added galactose ^{12}C. The galactose transport system is present in galactose fermenter cells and absent in glucose fermenter cells. These findings support the idea that galactose is accumulated in S. chevalieri cells through an energy-dependent, inducible, and specific transport system, and that one metabolic difference between galactose fermenter cells and glucose fermenter cells is the presence or absence of the galactose transport system. (auth)

35937 A STUDY OF THE CHLORIDE MOVEMENT IN THE GASTRIC MUCOSA BY RADIOACTIVE TRACERS. Villegas, Leopoldo (Instituto Venezolano de Investigaciones Cientificas (IVIC), Caracas, Venezuela). pp 85-91 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

A study was made of the chloride content, its distribution within the mucosa, and outflow velocity through the two surfaces of an isolated section of the stomach of a frog (Rana pipiens). The exchangeable chloride content in mmoles per kilogram of fresh mucosa is 67.7 ± 3.8. This value does not differ from the total chloride content measured electrometrically. The chloride outflow from the mucosa is represented by two exponentials: one rapid, in the extracellular space, and the other ten times slower in the cellular chloride. The extracellular space, corresponding to the rapid chloride outflow, is 25.4 ± 2.2 and does not differ significantly from the inulin space of 27.5 ± 3.3 measured under the same circumstances. The slow phase of the chloride outflow was used to study the flow rate emanating from the cells. Chloride-36 outflow through the mucosal surface of the cells is 1.27 ± 0.08 times greater than the outflow through the serosal surface, when the mucosa is maintained in short circuit between two sulfate solutions. This ratio increases to 2.09 ± 0.17 when histamine is added to both solutions up to a concentration of 2×10^{-5} mole/liter, or decreases to 0.45 ± 0.5 when chloride solutions are used. These observations suggest that the chloride movement in the mucosae maintained in short circuit is the result of three different procedures: simple diffusion, which is accomplished equally through both cellular surfaces; interchange diffusion, predominant in the serosal surface; and active transport, localized at the mucosal surface of the cells. (auth)

35938 GASTRIC ABSORPTION OF FAT IN THE TOAD (BUFO SPINOLOSUS) AND IN RATS. Orrego, Hector; de Dios Vial, Juan; Mena, Ismael (Universidad Catolica, Santiago). pp 97-102 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

The gastric absorption of fats has not been demonstrated up to now in any species. The absorption of oleic acid and triolein ^{131}I by the stomach with the pylorus tied off is described in the toad and a mammal, the rat. The results obtained with these animals are compared with those for controls and with those for other animals in which dinitrophenol or histamine was administered. It is evident that 32% of the fat absorption in the toad is by way of the stomach, which is blocked by the effect of dinitrophenol. In rats, on the other hand, 12% of the absorption is by way of the stomach and dinitrophenol shows no significant effect. The changes in the gastric cells during fat absorption are studied by electron microscopy, and are compared with the changes seen in the intestinal cells under the same conditions. It is concluded that, under the conditions of this experiment, there is absorption of fat from the stomach. In the toad results with triolein are interpreted as compatible with the presence of a lipase that is inhibited by the action of dinitrophenol. The latter phenomenon was not observed in the rat. (auth)

35939 INCORPORATION OF FISSION PRODUCTS BY FRESH-WATER PLANTS. Beninson, D.; Vander Elst, E.; Cancio, D. (Comision Nacional de Energia Atomica,

Buenos Aires). pp 227-32 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

The incorporation of fission products by fresh-water plants of the Buenos Aires region was studied in relation to the disposal of radioactive wastes to determine the concentration and discrimination factors of various nuclides important to radiological health. The experiments were made in large aquaria using five species of plants and radionuclides of ^{89}Sr, ^{137}Cs, rare earths using $^{144}Ce-^{144}Pr$ as examples, 95-Zr and ^{106}Ru. Calcium-45 was also used in the determination as a double tracer. The activity was measured by gamma spectrometry, or by radiochemical separation and counting. The results show that a discrimination factor for strontium can be defined in its incorporation together with calcium, which is effective for a wide range of concentrations. Contrary to other organisms, these plants do not discriminate strongly against strontium, and in one variety its incorporation is preferred. It seems that the incorporation of cesium depends strongly on the potassium concentration in the medium, although the discrimination concept does not seem to be immediately applicable to these two. The concentration factors of the rare earths, zirconium, and ruthenium were studied in terms of various parameters, and particularly important concentrations observed for cerium. (auth)

35940 EFFECTS OF PLACEMENT OF TWO PHOSPHATE FERTILIZERS ON PHOSPHORUS UPTAKE AND ON THE DEVELOPMENT OF BARLEY, USING P-32. Vega, V.; Sanin, S. J.; McClung, A. C. (Centro de Investigaciones Agricolas de Tibaitata, DIA, Bogota). pp 271-6 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

The Colombian cold climate soils generally respond to the application of phosphorus. The experiment was performed on a Bogotá River soil type of clay throughout the whole profile with pH of 4.6 and poor drainage characteristics. A study was made of the placement efficiency of two sources of phosphorus: concentrated superphosphate and monoammonium phosphate labeled with ^{32}P, as well as of the uptake of the phosphorus by barley. The fertilizers were applied in furrows below soil surface by machine and by hand; in rows above the surface of the soil by machine, and broadcast. A control was also included. No significant differences were observed in the response to either of the two sources or between the yields with the row or furrow treatments. Nor was there any difference between broadcast treatment and the control. However, there were differences between the row and furrow treatments and broadcast, and between the former and the control. Barley plants absorbed phosphorus from soil and fertilizer throughout the period of growth studied, but they absorbed a larger percentage from the fertilizer in the first stage of development, reaching a maximum at 30 days. The broadcast treatment and the control showed a difference in the phosphorus uptake of plants. (auth)

35941 FIXATION OF CARBON DIOXIDE BY NITRIFYING BACTERIA. Malavolta, E. (Centro Nacional de Energia Nuclear na Agricultura, Sao Paulo, Brazil); Crocomo, O. J.; Delwiche, C. C. pp 285-9 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

During the oxidation of the substrate, both Nitrosomonas and Nitrobacter store part of the available energy in the form of high-energy bonds of adenosinetriphosphate (ATP). This chemical energy is used to fix carbon dioxide. The nature of the reducing power is unknown at present, although there is some evidence to suggest that part of the ATP formed is consumed in the reduction of pyridine nucleotide. Nitrosomonas and Nitrobacter cells were shown to fix carbon dioxide along the same pathway as found in higher plant photosynthesis. Free extracts of Nitrosomonas and Nitrobacter cells, when incubated with $NaHC^{14}O_3$ and suitable cofactors, showed two ways of entry of carbon dioxide into organic compounds, one of them being, as expected, the carboxyoxalacetic carboxylase reaction. It becomes clear, therefore, that both microorganisms have typical autotrophic and heterotrophic mechanisms for the fixation of the carbon dioxide necessary for the primary synthesis of cellular material. (auth)

35942 USE OF P-32 AND I-131 TO STUDY THE EFFECT OF OXYTETRACYCLINE ON THE GROWTH OF CHICKENS. Valderas, Ramon (Universidad de Chile, Santiago); Valenzuela, Oscar; Berrios, Patricio; Olave, Heriberto; Seguel, Patricio. pp 291-6 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

The authors studied the way in which administration of chlorohydrate of oxytetracycline affects the growth of chickens of the Rhode Island Red breed, variety Harco Orchard. For this purpose, the incorporation of ^{131}I into the thyroid and of ^{32}P into the liver, bone, and muscle were selected as indices of metabolic activity and, as a general index, the variation in body weight. Measurements were made on birds after 30, 60, and 90 days of drug treatment. The birds were divided into four groups: control males and females, and treated males and females. The latter were administered orally every day 10 mg/kg of body weight of oxytetracycline until the time of killing. Each group was subdivided for the administration of ^{32}P (K_2HPO_4, free carrier) with radioactive measurements made at 12 and 24 hours after injection, and for the ^{131}I (INa, sterile solution), 24 hours after injection in the thyroid gland. The results obtained to date appear to indicate that the antibiotic produces an acceleration in body growth, thereby reducing the time of development only, as is shown by the analysis of variance. At the same time, the incorporation of ^{32}P in the liver appears to be increased and that of ^{131}I diminished at 30 days of age, which coincides with a period of accelerated growth from 0 to 45 days. (auth)

Radiation Effects

Refer also to abstract 36183.

35943 (BNWL-SA-147) PLUTONIUM PARTICLE-INDUCED NEOPLASIA OF THE CANINE LUNG. II. HISTOPATHOLOGY AND CONCLUSIONS. Clarke, W. J.; Palotay, J. L.; Bair, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [Apr. 13, 1965]. Contract AT(45-1)-1830. 18p. (CONF-650624-1). Dep. (mn); $1.00(cy), 1(mn) CFSTI.

From 2nd International Conference on Lung Tumors in Animals, Perugia, Italy.

Inhalation of $^{239}PuO_2$ particles by beagle dogs caused spontaneous death in 37 animals having lung burdens of from 0.5 to 48 μCi. Deaths occurred 2 to 56 months post-exposure and were preceeded by progressive lymphopenia and respiratory distress. The pathologic effects observed in the lungs of these animals consisted primarily of severe fibrosis followed by alveolar cell hyperplasia, and bronchiolar and squamous types of metaplasia. Five of the animals showed bronchiolo-alveolar carcinomas, an incidence of 14 percent as compared to a primary lung tumor incidence of 0.2 percent in canine necropsy material. All neoplasms originated in peripheral lung areas in association with particle retention, fibrosis, and bronciolo-alveolar metaplasia. The irradiated, proliferating cells, comprising the hyperplastic and metaplastic response to lung scarring, appeared to be the nidus of tumor formation. Metastases to the middle and left bronchial lymph nodes were seen in one dog. Although fibrosis per se is not a significant cause of lung cancer, it cannot be ignored as an important contributing factor when a known carcinogen is also present. (auth)

35944 (NP-14902) THE EFFECTS OF IONIZING RADIATION ON THE SINGLE-STRANDED DESOXYRIBONU-

CLEIC ACID FROM THE BACTERIOPHAGE ØX174. Final Report, April 12, 1960–April 12, 1963. Blok, Joh.; van der Sluys, I.; van Kesteren, L.; Cohen, J. A. (Leiden Rijksuniversiteit (Netherlands)). Contract No. 51. 28p. Dep.(mn).

The effects of x rays on the E. coli bacteriophage ØX174 and on solutions of DNA isolated from this phage were studied. The methods of exposure and dosimetry are described. The ratio between the 63% inactivation doses of the bacteriophage ØX174 and T4 in concentrated broth was determined. A value of 7.1 was obtained in accordance with results from others. From a sedimentation analysis of irradiated DNA solutions with known biological activity the fraction of inactivation due to breakage of molecules can be estimated. This fraction amounts to 20% or 50% depending on the medium in which the DNA was irradiated. Preliminary results are reported of measurements of the optical density of irradiated DNA solutions. (auth)

35945 (NP–15184) IMPLICATIONS TO MAN OF IRRADIATION BY INTERNALLY DEPOSITED STRONTIUM-89, STRONTIUM-90, AND CESIUM-137. (Federal Radiation Council, Washington, D. C.). Dec. 1964. 37p.

The possible biological effects of irradiation from internally deposited strontium-89, strontium-90, and cesium-137 are reviewed. Particular consideration is given to effects that might result from uptake of any one of these isotopes by a small fraction of the population over a short period of time under conditions leading to a cumulative average absorbed dose of the order of 25 rads or less to any tissue of the body within about one year after contamination. Because of differences in the behavior of radioactive strontium and radioactive cesium in the body and differences in the radioactive decay rate of their several isotopes, the implications of internally deposited radioactive strontium differ from those of radioactive cesium. Cesium-137, a beta-emitter, is distributed relatively uniformly throughout soft tissues and gives rise to a gamma ray-emitting daughter element, resulting in irradiation of essentially the whole body. Strontium-89 and strontium-90, on the other hand, are localized chiefly in the skeleton and teeth and give rise to energetic beta-rays, which are considered to affect mainly the bone, bone marrow, and adjacent structures. Tissues remote from bone, such as the gonads, receive comparatively little irradiation from radioactive strontium, with the result that effects on these tissues are regarded as non-limiting under the conditions of interest in this report. In the absence of direct observations of effects from internally deposited radioactive cesium and strontium in human beings, the evaluation was based on extrapolation from the effects of these radionuclides in experimental animals and the effects of irradiation from other sources in man. The observed effects have resulted, however, from irradiation under conditions that do not precisely duplicate those associated with deposition of radioactive cesium and strontium in the human body under the hypothetical conditions of interest. Hence, the conclusions derived herein are considered tentative. Risks of chief concern in the case of irradiation from internally deposited cesium-137 under the conditions in question are considered to be the carcinogenic effects on the exposed embryo and fetus; effects on the development of the exposed embryo and fetus; carcinogenic effects on the exposed child and adult; and genetic effects. Risks of chief concern in the case of irradiation from strontium-89 and strontium-90 under the conditions in question are considered to be the carcinogenic effects on the exposed embryo and fetus; disturbances of skeletal growth and development in the exposed embryo and fetus; and carcinogenic effects on the exposed child and adult. (C.H.)

35946 (NYO–1864-21) THE EFFECT OF X-RAY IRRADIATION ON PHOSPHOLIPID METABOLISM. Progress Report, October 1, 1964–May 31, 1965. Schwarz, Henry P. (Philadelphia General Hospital, Pa.). Contract AT(30-1)-1864. 19p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

Progress is reported in the development of micromethods for the separation, infrared spectroscopy, and the chemical characterization of tissue lipids; the detection of lipids in the skin of rabbits and human brain tissues; the localization of enzymes that catalyze the synthesis of lipids; and the effects of a single dose of 3000 R x radiation on the incorporation of ^{32}P into phospholipids of rat liver mitochondria. (C.H.)

35947 (TID–21075) THE POSSIBLE FORMATION OF DITHYMINE PEROXIDE IN IRRADIATED DNA. Wang, Shih Yi; Alcantara, Raul (Johns Hopkins Univ., Baltimore, Md. School of Hygiene and Public Health). [1964]. Contract AT(30-1)-2798. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The formation of thymine dimer from the ultraviolet irradiation of monomeric thymine and the role of the dimerization of thymine in photochemical alterations of DNA that result in biological damages are discussed. Reaction mechanisms involved in photochemical reactions of thymine and its derivatives are reviewed and the possible formation of dithymine peroxide in irradiated DNA is reported. (C.H.)

35948 (TID–22031) PROGRESS REPORT [ON GENETIC STRUCTURE OF NATURAL POPULATIONS] FOR OCTOBER 1, 1964-JUNE 1, 1965. Dobzhansky, Theodosius (Rockefeller Inst., New York). Contract AT(30-1)-3096. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI

Progress is reported in studies of genetic loads in natural and irradiated populations of Drosophila. Data are included from studies of epistatic interactions of the components of the genetic load in natural populations; the relation of genetic loads and genetic backgrounds; the genetic consequences of exposure to doses of 2000, 4000, or 6000 R x radiation in experimental populations maintained under conditions of relaxed natural selection after exposure for 3 successive generations; studies of chromosomal polymorphism in natural populations; and genetic diversity and selection in Drosophila populations. (C.H.)

35949 (TID–22039) THE MOLECULAR BASIS FOR THE MUTAGENIC AND LETHAL EFFECTS OF ULTRAVIOLET IRRADIATION. Progress Report, September 1, 1964-June 30, 1965. Grossman, Lawrence (Brandeis Univ., Waltham, Mass.). Contract AT(30-1)-3449. 3p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn

Progress is reported in studies of the molecular basis for the mutagenic and lethal effects of ultraviolet radiation. Data are included from studies of the effects of ultraviolet radiation on polynucleotide templates for RNA polymerase of Micrococcus lysodeikticus; the mutagenic effects of hydroxylamine; and the effects of ultraviolet radiation on the templating properties of polyuridylic acid of M. lysodeikticus. (C.H.)

35950 (TID–22047) STUDIES ON BIOLOGICALLY ACTIVE AMINES. Annual Progress Report, June 1, 1964-June 30, 1965. Kobayashi, Yutaka (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). July 9, 1965. Contract AT(30-1)-2085. 9p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI

Data are reported from measurements of the content of diamine oxadase in human maternal and fetal tissues at various times during pregnancy; the development of a double isotope method for the labeling of histamine; the effects of x radiation on the content of monoamine oxidase in rat brain and on the content of histidine decarboxylase in rat stomach. (C.H.)

35951 (UR-666) MITOCHONDRIA AND RADIATION SENSITIVITY OF CELLS. Tsinga, E.; Casarett, G. W. (Rochester Univ., N. Y. Atomic Energy Project). Apr. 13, 1965. Contract W-7405-eng-49. 76p. Dep. mn; $3.00 cy, $0.75 mn.

Albino male rats were exposed to 600 R total-body x irradiation and sacrificed thereafter at various time intervals up to 40 days. Samples of pancreas, intestine, thymus, liver, kidney, adrenal, and testis were prepared for histopathological and mitochondrial study by means of the opti-

cal-microscope. Globulation, clumping and disappearance of the mitochondria were observed in the degenerating radiosensitive cells of the intestine, thymus, and testis after irradiation. No changes in the morphology, number, or distribution of the mitochondria were detected in the radioresistant parenchymal cells of the pancreas, liver, kidney, and adrenal, or other radioresistant cells in any of the organs studied. It was concluded that mitochondrial morphology was relatively resistant to the actions of x rays and that the effects observed were not specific for irradiation but secondary to other injuries in cells. The mitochondrial content in the different kinds of cells was suggested as an important factor in the relative degree of the sensitivity or resistance of the cells to the cytocidal effects of irradiation, with radiosensitive cells generally containing a smaller mitochondrial content than radioresistant cells. (auth)

35952 (JPRS-29641(p.44-52)) THE EFFECT OF X-RAY ON THE FORMATION OF ORGANIC PEROXIDES IN THE BODY AND THE RELATIONSHIP BETWEEN ORGANIC PEROXIDES AND MERCAPTO COMPOUNDS. Chang, I-sheng; Mei, Shang-chun; Chou, Lin-li; Liu, Wen-yun; Miao, Shu-p'ing; Hung, Jui-ch'uan. Translated from K'o Hsueh T'ung Pao, No. 2, 151-4(Feb. 1965).

Peroxide contents were determined in the brain, liver, and testes of white male mice (Swiss strain) that had been exposed to 700 R x irradiation. Levels of peroxides in mouse tissues dropped slightly between 1 and 6 days post-irradiation. Antioxidant action of the mercapto groups affected accumulation of peroxides. Hence, it is suggested that this is the mechanism for peroxide accumulation following irradiation. Choline esterase activities were higher in the brain and liver of irradiated mice. Increased acetylcholine accumulations following irradiation could be due to radioinduced excitation of the nervous system. (H.G.D.)

35953 THE ROLE OF HUMORAL FACTORS IN THE MODIFICATION OF IMMUNITY RESPONSES UNDER THE INFLUENCE OF IONIZING RADIATIONS. EXPERIMENTAL INVESTIGATIONS ON RABBITS. Petrescu, D. (and others). Acad. Rep. Populare Romine, Studii Cercetari Fiziol., 9: 69-75(1964).

Experimental investigations were made on the validity of the hypothesis according to which, in addition to the direct action exercised on the antibody-forming cells by ionizing radiations, an indirect effect due to the intervention of some humoral factors activated by irradiation is also noted. To this end, normal rabbits were injected serum taken from other rabbits (donors) irradiated 24–48 hours previously with high doses of Roentgen rays. The evolution of the antibody titre following antigen injection was then examined in the rabbits treated with serum of irradiated donors and in controls similarly treated with normal homologous serum obtained from non-irradiated donor rabbits. Prolonged administration of serum of irradiated rabbits to normal rabbits under immunization with heterologous antigens was found to induce a more intensive immune response. The stimulating action on immunogenesis of the irradiated rabbit sera demonstrated that humoral reactions tending to compensate the direct inhibitory action of Roentgen rays on the antibody-forming cells take place in the irradiated organism. (Rumanian Sci. Abstr., Nat. Sci., Vol. I, No. 8, 1964)

35954 A COMPARISON OF THE ULTRAVIOLET EFFECT ON THE MITOTIC RECOMBINATION IN TWO DIFFERENT CISTRONS OF ASPERGILLUS NIDULANS (PRELIMINARY COMMUNICATION). Kwiatkowski, Zbigniew; Grad, Krystyna (Univ. of Warsaw). Acta Microbiol. Polon., 14: 15-18(1965).

The effects of uv light on mitotic recombination in two different cistrons of A. nidulans were compared. The phenotypes of the diploids studied were as follows: diploid 20, green conidia, requiring p-aminobenzoic acid; diploid 24, green conidia, requiring adenine. In diploid 20, paba 19 and paba 2 are alleles of paba 1 cistron, and in diploid 24, ad 20 and ad 16 belong to the same ad 8 cistron. Two methods of selection of mitotic recombinants were used: (1) selection for yellow and white conidia, and (2) selection for cis-heterozygotes from original trans-configuration. Uv irradiation increased the incidence of recombination in paba 1 cistron, between two very closely linked sites: paba 2 and paba 19. The range of increase was about 100 times when compared with the results under control conditions. Induced reversions were excluded experimentally as a cause of the observed increase in the incidence of the selected paba-independent colonies. No such increase in the recombination frequency was observed when the other diploid with two mutations in ad 8 cistron was irradiated under the same conditions. The rate of spontaneous intracistron recombination is in both investigated cistrons of the same range. It is suggested that further investigations should be made to find out whether the situation in uv-induced intracistron recombination resembles the hot spots of induced mutations in phages, where a mutagen may increase the mutation frequency at particular sites, while leaving other sites unaffected. When the position of the selected marker (white or/and yellow) on the chromosome arm is distal, the probability of exchange, whatever the mechanism of recombination, at any place on the long chromosome segment is high. In such a case, the site-specific action of uv irradiation may be difficult to detect. This explains why the induced increase in the recombination frequency in the long segments of chromosome I and II in diploid 20 and 24 was observed, while in the same diploid 24 no effect on intracistron recombination was found. No increase of the rate of mitotic reduction (haploidization) after the uv treatment was found. (BBB)

35955 THE INACTIVATING AND MUTAGENIC EFFECT OF ULTRAVIOLET IRRADIATION ON NEISSERIA MENINGITIDIS. Lie, Sverre (Univ. of Oslo, Norway). Acta Pathol. Microbiol. Scand., 63: 456-68 (1965).

The diplococcal nature of the colony-forming unit may represent a fundamental difference between the mode of replication in this species and that of other bacteria such as Escherichia coli, which are more generally used in radiation studies. Such a biological difference might be expected to result in a fundamentally different response to the effects of uv light. These experiments accordingly were planned as a comparison between the effects of uv light on N. meningitidis and E. coli, namely the lethal and mutagenic effects. With N. meningitidis most actively dividing cells (99%) are killed in an exponential fashion while the rest is killed at a rate only half of that of the majority. When the cells are subjected to starvation before irradiation, a typical multihit (sigmoidal) survival curve is obtained. Starved cells of E. coli had a greater resistance to uv light than actively dividing cells, but the shapes of the survival curves were in both cases of the typical sigmoidal type. The mutation rates from str-s to str-r and from auxotrophy to phototrophy were measured in three different strains of N. meningitidis. Uv light was not found to increase the mutation rates to any significant extent, but experiments with E. coli showed uv light to be a very potent mutagen in this species. (BBB)

35956 THE INFLUENCE OF THE VEGETATIVE NERVOUS SYSTEM ON THE MOTOR FUNCTION OF THE INTESTINES OF THE DOG AFTER IRRADIATION. Kulesza, Romuald; Lipinski, Stanislaw. Acta Physiol. Polon., 16: 227-34(Mar.-Apr. 1965). (In Polish)

The sensitivity to neurohormones of the small intestine of dogs in acute post-radiation disease was studied. Dogs of both sexes, weighing 8 to 22 kg, were given whole-body x-irradiations (total dose 600 R). Two-centimeter specimens of the small intestine, secured on the seventh day after the irradiation, were examined by the method of Magnus. The influence of acetylcholine, histamine, serotonin, adrenaline and noradrenaline on the character of contractions of irradiated and unirradiated dog intestine was studied. In other experiments, the influence of the aforementioned neurohormones on the dog intestine was

studied after poisoning the intestine with pendiomid, regitine and atropine. The experimental results showed that in acute postradiation disease in dogs vegetative nervous regulation of the motor function of the small intestine is disordered. In irradiated dogs mainly the sympathetic system was impaired. The direct action of the neurohormones on the intestinal muscularis was preserved in acute postradiation disease. (auth)

35957 IMMUNIZATION EXPERIMENTS WITH IRRADIATED LARVAE. II. THE RESISTANCE-INDUCING EFFECT OF TREATMENT WITH IRRADIATED LARVAE OF ASCARIDIA GALLI IN CHICKENS. Varga, I. (Univ. of Veterinary Sciences, Budapest). Acta Vet. Acad. Sci. Hung., 14: 399-409(1964).

Attempts were made to determine whether a previous infestation of chickens by irradiated larvae of A. galli influences subsequent challenge infestation. Two experiments were carried out. In the first, groups, each consisting of 10 six-week-old chickens, were infested partly with non-irradiated or with irradiated (10 and 20 kR) larvae of A. galli. In the first experiment infestation took place once (single vaccination), while in the second birds were infested twice at an interval of one week (two vaccinations). Three weeks later the group was infested with normal larvae. As soon as the latter group showed sexually mature worms, all experimental birds were sacrificed. Birds discharging worm eggs occurred in all groups except those vaccinated twice with irradiated larvae. In birds vaccinated once, no resistance developed. In birds vaccinated twice, however, a strong retardation in development of the challenge worms was observed. The degree of resistance, though similar in the three groups, was most pronounced in the group vaccinated with larvae irradiated with 10,000 R. Most of the challenge worms recovered from the resistant birds consisted of 2nd, 3rd, and 4th stage larvae. The results show that although the irradiated parasites retain their immunogenic capacity, they remain sexually sterile. Worms developing from irradiated larvae were female specimens unable to produce fertile eggs. Many of the worms showing retarded development proved to be 2nd stage specimens having not molted in the host, or 3rd and 4th stage larvae. Consequently, it is inferred that a close relation exists between the mechanism of resistance and the processes of molting. (BBB)

35958 MEDICAL EVALUATION OF AIRMEN EXPOSED TO ALTITUDES IN EXCESS OF 50,000 FEET. Barron, Charles I., Schwichtenberg, A. H.; Secrest, Robert R. Aerospace Med., 36: 665-8(July 1965).

With the advent of the supersonic commercial transport, concern has been expressed at the possible biological effects to crew and passengers of ionizing radiations, ozone, decompression, thermal extremes, accelerations, and rapid time-zone changes. During the past 10 years military and civilian pilots have been exposed to environmental conditions existing at contemplated supersonic transport flight altitudes for total periods of 250 to 2,000 hours. These pilots have undergone extensive medical examinations and the results of the examinations are compared to those obtained from pilots with no exposure above 50,000 feet. The examinations were especially designed to assess the effects of high altitude radiation and included extensive ophthalmological, neurological, hematological, and genetic studies, as well as background radiation determinations. In not a single case in the exposed group could a physical defect be causally related to high altitude radiation. The findings indicate man's ability to safely tolerate the environmental stresses existing in the high altitudes. Based upon this study there is every reason to expect that the knowledge gained in design reliability and safety can be successfully applied to the supersonic transport making high altitude, high speed flight as safe and as routine as current jet operations. (auth)

35959 KINETICS OF IRON AND COPPER LEVELS IN SERUM UNDER DIFFERENT DOSES OF WHOLE-BODY IRRADIATION IN RATS. Schmitt, W.; Braun, H.; Coenen, J. (Universitaet, Wurzburg, Ger.). Aerztl. Forsch., 19: 320-5(June 10, 1965). (In German)

Albino rats in groups were subjected to whole-body γ radiation of 20, 50, 100, 200, and 600 R for studies of the blood serum iron, the blood serum copper level, and the latent and total capacity of binding iron. The determination of these metals was made 9, 72, and 144 hours following radiation. The serum copper level showed a biphasic course. The serum iron level increased initially with doses of 50 and 600 R but then decreased continually, as was also the case with those animals who received radiation doses of 20, 100, and 200 R. The latent capacities to bind iron were different: lethal doses caused a decrease and sublethal doses a moderate increase. The total capacity to bind iron shows approximately the same situation in the various groups as the latent capacity to bind iron. (tr-auth)

35960 QUANTITATIVE STUDIES OF INDUCED MUTATIONS IN PEAS. II. MUTAGENIC EFFECT OF OXYGEN. Gelin, O.; Ehrenberg, L.; Blixt, S. (Weibullsholm Plant Breeding Inst., Landskrona, Sweden). Agri. Hort. Genet., 17: 265-74(1959).

Comparison was made of the abilities of x rays and increased oxygen tension to induce mutations in peas. Seeds of the variety Weitor (Weibull strain 702) were treated for 8 to 52 days at an oxygen pressure of 50 atm. In X_1 plants the disturbing influences of the oxygen treatment were linearily dependent on the dose, determined as the duration of the treatment. This concerned the survival of the plants and their height at maturity. For these properties a 50% decrease was caused by treatments for 30 to 40 days, the survival being possibly stimulated by treatments of short duration as found in the radiation experiments. The O_2 treatment also decreased the number of branches per plant and the number of seeds per plant with a linear dependence on the dose. As a mutagenic agent, the efficiency of O_2 was about the same as that of x rays. When compared to the radioinduced mutations, it was evident that a fairly large fraction of the oxygen mutants had a variegated appearance In the pea variety studied, the most effective x-ray dose was found to give 11.4% mutated plant progenies. The highest mutation rate discernible after treatments with oxygen was very close to this value, i.e., in the pea the two agents seem to possess about the same mutagenic specificity. This confirms the great similarity in biological action of x rays and high-pressure oxygen as reported previously. (TCO)

35961 QUANTITATIVE STUDIES OF INDUCED MUTATIONS IN PEAS. IV. SEGREGATION AFTER MUTATION. Blixt, Stig (Weibullsholm Plant Breeding Inst., Landskrona, Sweden). Agri Hort. Genet., 18: 219-27(1960).

In methodologic investigations of mutations induced by x rays, oxygen, and other agents it was demonstrated that the tissue heterozygous for the mutation was restricted to one branch. It was pointed out that heterozygotes for some mutants were under-represented in X_2 plants. A hypothesis was presented according to which this under-representation could be explained by the heterozygous tissue being restricted to part of a branch. Further evidence concerning this hypothesis with a formula for expected segregation ratios after mutation is now presented. As a consequence the segregation ratio the first two generations after mutation is a disturbed Mendelian ratio; deviating only partly it may be called a modified Mendelian ratio. The mode of segregation after mutation from a dominant to a recessive allele in one gene is postulated. The size of the mutated sector is approximated to, on an average, about half a branch. The genotypical constitution of the mutated X_1 plant regarding the mutated gene is denoted AA + Aa. The X_2 segregation is determined by one part of the X_1 plant giving only AA plants and another part segregating 1AA:2Aa:1aa. The expected segregation in X_3 will therefore be nAA:2Aa:1aa. The X_4 segregation will be an undisturbed Mendelian segregation. The segregation numbers found for chlorophyll mutation in peas show good agreement with the n:2:1 hypothesis. The possible causes for the underrepresentation of mutant tissue within one branch are discussed. (TCO)

35962 STUDIES OF INDUCED MUTATIONS IN PEAS. VII. MUTATION SPECTRUM AND MUTATION RATE OF

DIFFERENT MUTAGENIC AGENTS. Blixt, S.; Ehrenberg, L.; Gelin, O. Agri. Hort. Genet., 21: 178-216(1963).

Twelve experiments of the effect of mutagenic agents in peas are presented. The mutagens studied were x rays, fast neutrons, ethyleneimine, ethyleneoxide and T_2O. The radiation sensitivity of the varieties Weitor and Witham Wonder is discussed. In laboratory or greenhouse experiments a difference in x-ray sensitivity is indicated. Witham Wonder being most sensitive, while no difference in the reaction to fast neutrons is found. In experiments under field conditions these varieties seem to react differently to x rays as well as to fast neutrons, Witham Wonder being the more sensitive variety. The method of calculating the mutation rate as the frequency of mutated X_2-plants per analyzed X_2-plants is discussed. This method is found to have several advantages, it is for instance comparatively insensitive to variations in progeny size and in the size of the mutated sector. The hypothesis put forward by GAUL, that this method directly reflects the frequency of mutated initial cells, is based on the assumption that the mean segregation frequency within the mutated sector, f, is constant. It is pointed out that there are indications that the value of f may not be considered generally a constant, but is influenced by the mutagens used as well as by the genotype of a treated variety. It is experimentally shown that the scoring of mutations in the seedling stage of the X_2-generation is a good approximation of the chlorophyll mutation rate, while the frequency of morphological and other mutations is grossly underestimated. It is found that the mutation rate seems not to be affected by differences in the water-content of the seeds at irradiation. The mutation spectrum of the material here presented is analyzed. A specific effect of the mutagens used, concerning differences in the frequencies of the different mutation types, is probable. A specific response to x rays of different varieties, most probably genetically conditioned, is very probable. (auth)

35963 EFFECTS AND AFTEREFFECTS OF RADIOACTIVE FISSION PRODUCTS ON THE YIELD AND QUALITY OF GRAIN OF CERTAIN FIELD CROPS. Il'ina, G. V.; Tydkii, S. G. (Moscow State Univ.). Agrokhimiya, No. 3, 80-7(1964).

Radioactive fission products were introduced into the soil on the surface, in the form of a radioactive solution in which strontium-90 and yttrium-90 predominated, in an amount of millicurie per square meter with respect to total activity, followed by cultivation of the soil. A determination of the activity in the grain and straw of wheat, oats, barley, buckwheat, millet, sunflower, peas, vetch, clover, alfalfa, sweet clover, foxtail millet, and dew grass indicated that the products of agricultural crops grown in such soil are characterized by different values of both the absolute activity and of the activity related to 1 gram of calcium, as well as of that expressed per unit starch equivalent. The highest value of strontium activity per gram of calcium in the plants studied was found in buckwheat among the grain crops (in the seed), in vetch among the leguminous grains (with respect to hay), and dew grass (with respect to hay) among the perennial grasses. The introduction of radioactive fission products into the soil exerted essentially no influence on the germination of the seeds of the yield obtained from most of the crops. An exception was sunflower, in whose seeds germination was greatly suppressed. In the second generation of plants, a negative aftereffect of the radioactive fission products was detected for a number of crops; this aftereffect was manifested in a restraint of the growth of the sunflower, millet, and the formation of heads in millet and foxtail millet under the conditions of a small-scale field experiment. No aftereffect of the radioactive fission products was detected in the germination of the seeds of second-generation plants. Nor were any differences ascertained in the value of the activity of the grain crop of the second-generation crops, obtained both from uncontaminated and from active seeds of the yield of plants of the first generation. (CFSTI)

35964 THE EFFECT OF IRRADIATION ON THE INTACT SUPRAVITALLY STAINED MAMMALIAN CELL. Scanlon, Paul W. (Mayo Clinic and Mayo Foundation, Rochester, Minn.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 952-63(Aug. 1965).

Dynamic changes induced by x radiation were observed in wet drop preparations of mammalian cells after supravital staining. Most of the morphologic studies carried out to date using conventional staining methods represent a single slice in time, which do not represent the continuing dynamic changes that are much more readily apparent in studies using intact supravitally stained cells. It is true that the supravital stains are cytotoxic and poisonous to a degree to the metabolism of normal cells, but they have the advantages usually of being very slow poisoners so that, by constant comparison against normal controls, this effect can be minimized. Further, such study allows for easy comparison between the lethal effects of irradiation and the somewhat similar effects produced by other causes of cell death. Changes are described that lend some support to the plasma-membrane-disruption theory or enzyme-release hypothesis of interphase radiation damage. (auth)

35965 THE RESPONSE OF THE OLFACTORY EPITHELIUM OF THE ADULT AXOLOTL (SIREDON MEXICANUM) TO ROENTGEN IRRADIATION. Brunst, V. V. (Roswell Park Memorial Inst., New York). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 964-83(Aug. 1965).

The anterior portion of the head was x irradiated in 70 adult axolotls (Siredon mexicanum), 4 to 5 years old, 1,000 R being administered to 10 animals, 3,000 R to 20, 6,000 R to 20, 8,000 R to 10, and 10,000 R to 20; 5 animals served as untreated controls. Specimens fixed at various intervals following irradiation were studied histologically. After irradiation with 1,000 R, the olfactory epithelium appears normal. After irradiation with 3,000 R, the olfactory epithelium appears normal in many places. Elsewhere in the olfactory epithelium there may be slight damage, characterized by reduction of the distal "anucleate" portion, or serious damage, characterized by complete disorganization of all layers and disappearance of the anucleate portion. After irradiation with 6,000 R, the olfactory epithelium appears normal in some places. Occasionally, the interstitial epithelium undergoes abnormal developments, becoming unusually thick, with very large or even giant nuclei. Serious damage to the olfactory epithelium is characterized by reductions in the number of cells, disorganization of all layers, and disappearance of the distal anucleate portion. After irradiation with 8,000 or 10,000 R, the olfactory epithelium appears normal in some places. Elsewhere in the olfactory epithelium, there may be the same kinds of damage as occur after irradiation with smaller doses. In axolotls, the olfactory epithelium is far more radioresistant in adults than in young animals. In the latter, the olfactory epithelium is one of the most radiosensitive areas of the head. The olfactory epithelium is more radiosensitive than the cornea in young animals, but the reverse is true in adults. The radiosensitivities of different tissues vary with age in different ways. Some tissues have much the same radiosensitivies in adults as in young animals, whereas others are far less sensitive. (auth)

35966 EFFECTS OF RADIATIONS ON BLUE-GREEN ALGAE. II. EFFECTS ON GROWTH. Kumar, H. D. (Westfield Coll., London). Ann. Botany (London), 28: 555-64(Oct. 1964).

The unicellular blue-green alga Anacystis nidulans was repeatedly treated with x rays and radiophosphate (^{32}P) during successive subcultures. The strains so obtained were characterized by comparison with the untreated control strain, with respect to their resistance to ultraviolet light, x rays, streptomycin, and isoniazid. The ^{32}P-treated strain was found to be relatively more resistant to streptomycin than the untreated strain and the x-rayed strain was found to be relatively more sensitive to isoniazid than the control. In old cultures, cells of the x-rayed strain were significantly smaller than those of the untreated strain. The effects of x rays on cell- and heterocyst dimensions of the

nitrogen-fixing alga Chlorogoea fritschii Mitra were studied. In the irradiated material the cell diameter and heterocyst breadth were greater, rather than smaller, than in unirradiated material. (auth)

35967 THE EFFECTS OF γ-RADIATION ON ^{32}P-INCORPORATION INTO VARIOUS RNA FRACTIONS FROM EHRLICH ASCITES TUMOUR CELLS. Takamori, Yasuhiko; Akaboshi, Mitsuhiko; Honjo, Ichijiro (Osaka Univ.). Ann. Rept. Sci. Works, Fac. Sci., Osaka Univ., 12: 55-65(1964).

The effects of γ irradiation on the incorporation of ^{32}P into various RNA fractions in nucleus and cytoplasm were investigated with Ehrlich ascites tumor cells. The specific activities of DNA and nuclear RNA were reduced significantly with dose of 1,000 R, whereas that of cytoplasmic RNA was unaffected or even slightly enhanced. The nuclear RNA was further fractionated with dilute phosphate buffer, and two types of RNA: n-RNA_1 and n-RNA_2 were obtained. The incorporation of ^{32}P into n-RNA_2 was distinctly decreased by radiation, but no inhibition was found in the case of n-RNA_1. The n-RNA_2, the so-called nucleolar RNA, was separated into two subfractions by the phenol method. The ^{32}P-incorporation into nucleolar RNA_2 (occurring in interphase plus phenol phase) was reduced to 67% of that of the non-irradiated control, and that into nucleolar RNA_1 (occurring in aqueous layer) to 10%. It is concluded that the radiation-induced inhibition in RNA-synthesis substantially occurs in the nucleus, especially in the nucleolus-chromosomal fraction. (tr-auth)

35968 BIOCHEMICAL METHODS OF STUDY OF THE RADIOSENSITIVITY OF MALIGNANT TUMORS. Kaercher, K. H. (Czerny Krankenhaus, Heidelberg). Arch. Klin. Expti. Dermatol., 219: 498-500(June 25, 1964). (In German)

Enzymatic studies indicate that melanomas differ in their radiosensitivity. Probably, a general effect of ionizing radiation is to inactivate coenzymes. The increased permeability of the cell membranes that follows soon after irradiation indicates that enzymes may be released from the cell mitochondria or cytoplasm. Malic dehydrogenase is released from the mitochondria of radiosensitive tumor cells into the blood within min or hr after irradiation. Estimation of the blood activity of this enzyme gives a good picture of the relative radiosensitivity of the irradiated tumor. Lactic dehydrogenase activity in blood is also an indication of tumor radiosensitivity, but the presence of this enzyme is not as definite a measure of radiosensitivity as malic dehydrogenase is. Numerous clinical studies have shown that measurements of these enzymes are good indicators of the radiosensitivity of the tumor, the effect of the irradiation, and the treatment prognosis. These types of enzyme studies could be very valuable in measuring the effects of irradiation of tumors on the surface of the body, such as melanomas, because they can be correlated readily with the clinical progress of the irradiation treatment. (BBB)

35969 ON THE CHOICE OF BIOLOGICALLY IMPORTANT SPECTRAL RANGES OF GLOBAL IRRADIATION USING A RADIATION MEASUREMENT SPHERE ACCORDING TO LARCHE-SCHULZE. Burger, A. R.; Voight, G. (Institut fuer Biophysik Deutsche Akademie der Wissenschaften, Berlin). Arch. Physik. Therapie, 13: 455-62(Nov.-Dec. 1961). (In German)

The photochemical reactions of uv irradiation with components of living tissue are the results of direct and indirect interactions. The two most important reactions are development of erythema and pigmentation. Erythema consists of expansion of skin capillaries which follows within 2 to 6 hr after exposure. The erythema produced by uv occurs at two different absorption maxima, corresponding to those of protein and of the stratum corneum. For proteins, at the absorption maximum of about 280 mμ, erythema is the result of histamine production in the surface layers of the skin. Between 280 and 320 mμ uv irradiation is absorbed in the deeper skin layers, where it causes changes in the DNA of the cell nuclei and cell disturbances that cause release of histamine. At an increased level of erythema production, tanning is caused by pigment formation. This takes place at the boundary layer between the germinal layer and the papillary layer of the skin. The coloration is due to melanin bodies, consisting of deoxyphenylalanine, formed enzymatically from tyrosine between 310 and 400 mμ. The relative biological effectivity of these and other wavelengths can be measured by use of the Larche-Schulze sphere, which acts as a receptor organ. (BBB)

35970 IONISING RADIATIONS AND PLANT IMPROVEMENT. Brock, R. D. (Commonwealth Scientific and Industrial Research Organization, Canberra). At. Energy Australia, 8: 18-21(Apr. 1965).

A review on radioinduced mutations and genetic techniques is presented. The mechanism of induced mutations is discussed. Varieties of agriculture plants produced by induced mutation are listed by year and country. (P.C.H.)

35971 THE SENSITIVITY OF SPERM TO X RAYS COMPARED WITH OPTIONAL PARTHENOGENESIS AND BACILLUS ROSSIUS. Benazzi, Mario; Scali, Valerio. Att. Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat. (8), 36: 794-7(June 1964). (In Italian)

Males of planaria, Dugesia lugubris, were exposed to x ray doses from 500 to 20,000 R and the sperm used for sexual fertilization of females. The sex ratio of the descendents was used as the measurement of the radiation effects. With doses above 10,000 R no males were obtained, indicating the destruction of the sperm with all the ova being developed parthenogenetically. The similarity with reproduction of Bacillus rossius is discussed. (J.S.R.)

35972 CONTRIBUTIONS TO THE ORTHOLOGY AND PATHOLOGY OF "SPERMATOGONIOGENESIS" IN RATS. [Hilscher, W.] (Medizinische Akademie, Duesseldorf, Ger.) Beitr. Pathol. Anat. Allgem. Pathol., 130: 69-132(June 1964). (In German)

Formation of spermatogonia was investigated in the germinal epithelium of rat testes by the use of x radiation (600 and 1200 R doses), combined with ^{3}H-thymidine and ^{14}C-thymidine to investigate DNA synthesis by autoradiography. The results showed that spermatogoniogenesis begins with an unequal cell division. Two unequivalent daughter cells arise from one primordial germ cell (0_2). One of the daughter cells is once again a primordial germ cell (0_2), the other is a stem cell (0_1). Arising from the latter through five further mitoses come the dust-like spermatogonia 1 and 2, the intermediate spermatogonia, the crust-like spermatogonia, and the resting spermatocytes. The S-phases of the individual generations of spermatogonia become longer and longer with increasing differentiation. Spermatogoniogenesis terminates with the S-phase of 5. The S-phases of the individual spermatogonia generations were determined by double labeling with ^{3}H-thymidine and ^{14}C-thymidine as well as on the basis of the reciprocity of the proportions of the silver grain counts and the length of the S-phase. The values for the S-phases of the individual spermatogonia generations are: for spermatogonia generation 0, 14.5 hr; for 1, 15.6 hr; for 2, 16.7 hr; for 3, 19.3 hr; for 4, 23.3, and for 5, 26.2 hr. When spermatogonia were selectively damaged with x rays (600 R surface dose,) with the Leblond and Clermont classification of the stages, it was possible to recognize a pattern of damage which is not confined only to the spermatogonia layer, but is concerned in several cycles. Entire generations of spermatogonia were chiefly damaged during the S-phase; they are especially sensitive at the beginning of the S-phase. The spermatogonia generations 0 (0_2 and 0_1), 1, 2, and 3 damaged by the x rays die off during the first three days. Four days after irradiation the germinal cells damaged as crust-like spermatogonia begin to deteriorate, and seven days after irradiation, necroses appear in the spermatocytes damaged as resting spermatocytes. Thus defects arise in the germ-cell stratum of the spermatogonia layer through irradiation, which

are referred to as gaps. These gaps, which frequently correspond with the S-phase area of the individual spermatogonia generations, travel gradually towards the lumen of the tubules. As with the spermatogonia marked with ^3H in the normal seminiferous tubule, the passage of a germ-cell gap into the next higher layer lasts 13 days. The duration of the cycle is accordingly not substantially influenced by the irradiation. It is, however, subject to larger variations than in normal seminiferous tubules. The life-span of spermatogonia generations 1 and 2 is two days in each case, that of 3 is 2 to 3 days and that of 4 is about 2 days. The spermatocytes have a life-span of 21 to 22 days, and the length of life of the spermatids is 9 days. The life-span of the primordial germ cells corresponds to the duration of a cycle, and is thus 13 days, as is that of the stem cells and the spermatozoa. (BBB)

35973 THE CAPACITY OF THE BACTERIAL HOST FOR THE REPRODUCTION OF THE RNA PHAGE f2. Newbauer, Zdenek; Zavada, Vojtech (Charles Univ., Prague). Biochem. Biophys. Res. Commun., 20: No. 1, 1-3(June 18, 1965).

The extent to which the infectious capacity of RNA phage f2 was affected by the preinfection of the host with UV inactivated phage T2 (UV-T2) was investigated. The capacity for f2 in E. coli differed remarkably, as for its uv-sensitivity, from the extremely uv-resistant capacity for autonomous virulent phages. In experiments with bacteria preinfected with uv-T2, the colony-forming ability and the capacity for f2 decreased to about the same degree. Hence, it is suggested that only those cells that survived the UV-T2 infection are able to reproduce f2. (H.G.D.)

35974 A METHOD FOR SELECTIVE ENRICHMENT OF MUTANTS BASED ON THE HIGH UV SENSITIVITY OF DNA CONTAINING 5-BROMOURACIL. Bonhoeffer, F.; Schaller, H. (Max-Planck-Institut fur Virusforschung, Tuebingen, Ger.). Biochem. Biophys. Res. Commun., 20, No. 1, 93-97(June 18, 1965).

Reconstruction experiments were performed to demonstrate that wild type Escherichia coli bacteria can be uv-sensitized by BU incorporation, while a culture of the corresponding mutants remains relatively insensitive to long wavelength uv under the same conditions. (auth)

35975 ODD-NUMBERED FATTY ACIDS IN MICROCOCCUS RADIODURANS. Knivett, V. A.; Cullen, Julia; Jackson, M. J. (Twyford Labs., London). Biochem. J., 96: 2c-3c(July 1965).

Micrococcus radiodurans is highly resistant to γ radiation. Analysis of the composition of fatty acids in the extractable lipid showed that the percentage composition was variable but C_{15} and C_{17} acids were always present, and in certain cases were major components. The cell walls were found to contain a high proportion of lipids and L-ornithine as the chief diamino acid in the mucopeptide. Both odd- and even-numbered straight-chain saturated and unsaturated fatty acids were found in this organism. (C.H.)

35976 INACTIVATION OF ORIENTED BACTERIA WITH POLARIZED ULTRAVIOLET LIGHT. Gray, D.; Kilkson, R.; Deering, E. A. (Yale Univ., New Haven, and New Mexico Highlands Univ., Las Vegas, Nev.). Biophys. J., 5: 473-86(July 1965).

Aligned deoxyribonucleic acid (DNA) molecules exhibit a large absorption anisotropy in the ultraviolet (UV) region of the spectrum. Also, the UV action spectra of most bacteria resemble the absorption spectrum of DNA, implying that inactivation is directly proportional to the UV absorbed by the bacterial DNA. Hence, the UV sensitivity of aligned uniaxial bacteria might be anisotropic with respect to polarization of the incident UV. Any inactivation anisotropy would depend upon the orientation of DNA within the bacteria, as well as upon the alignment of bacteria, and could provide a more sensitive indication of in vivo DNA orientation than is presently available using optical methods. Using an electric field of 3.5×10^6 cycles/second, samples of bacteria of strain LS-301 were aligned in a quartz cell and were irradiated with UV (γ = 2652 A) polarized perpendicular and parallel to the alignment direction. The resultant survival curves resolved no inactivation anisotropy. This result is interpreted to mean that there was insufficient bacterial DNA alignment to give a detectable anisotropy. The minimum average DNA alignment necessary to have resolved an anisotropy is calculated to be 15 per cent in an axial direction (bases perpendicular to the bacterial axis) or 30 per cent in a radial direction (bases parallel to the bacterial axis). (auth)

35977 ON THE COURSE OF THERMAL DENATURATION OF DEOXYRIBONUCLEIC ACIDS AFTER γ-IRRADIATION. Bohacek, Jiri; Blazicek, Gustav (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Biophysik, 2: 233-8(1965).

Changes caused by the effects of γ irradiation on DNAs of various origin were followed by a spectrophotometric method at differing thermal denaturation curves. It was found that all measured bacterial DNAs as well as DNA isolated from calf thymus, irradiated by exposures higher than 5×10^4 R, produced significantly decreased T_m values with concomittantly decreased hyperchromic effect and changed transition intervals obtained in 10^{-2}M sodium phosphate, 10^{-3}M EDTA medium at pH 7. It was also observed that higher γ irradiation exposures caused the loss of renaturation ability of Escherichia coli DNA. (auth)

35978 THE RELATIVE BIOLOGICAL EFFICIENCY (RBE) OF 30-Mev ELECTRONS ON HAPLOID YEAST. Hettinger, Gunnar; Bergman, Sven; Oesterberg, Stig (Univ. of Umea, Sweden). Biophysik, 2: 276-81(1965).

The biological efficiency of 30-Mev electrons on a haploid strain of Saccharomyces cerevisiae was studied. The ability of a yeast cell to form a macrocolony defined survival. Cell suspensions were irradiated homogeneously by test and reference radiation simultaneously in different phantoms. The dose measurements were based on Fricke dosimeters. The RBE values obtained for 30-Mev electrons were: 1.04 ± 0.03 with cobalt-60 gamma rays as reference and 0.88 ± 0.03 with 200-kvep x rays as reference. The values agree closely with those recently reported for highly energetic photons from a betatron. (auth)

35979 THE NATURAL RADIATION EFFECT OF THE RESPIRATORY TRACT. Jacobi, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Biophysik, 2: 282-300(1965). (In German)

The natural radiation exposure of the human respiratory tract is mainly caused by the inhalation of the short-lived decay products of radon (^{222}Rn) and thoron (^{220}Rn). From the particle size distribution of the carrier aerosol of these decay products their deposition in different regions of the human respiratory tract and the resulting activity distribution is estimated for normal breathing conditions, taking into account the biological elimination from the alveolar region and the ciliar transport in the bronchial tree. The corresponding α-depth dose distribution in the bronchial epithelium is derived, taking into account the α-absorption and the variation of stopping power with α-energy. The resulting natural radiation exposure of the bronchial epithelium is considerably higher than it was hitherto assumed. The maximum dose rate is reached in the segmental and subsegmental bronchi, where a mean natural radiation exposure of about 100 Mrad/a or 1 Rem/a must be expected in the basal cell layer. The results are discussed and compared with the RaF (^{210}Po)-inhalation dose by cigarette smoking. (auth)

35980 THE EFFECT OF γ RADIATIONS ON DATURA INNOXIA MILLER GROWING IN EGYPT. Karawya, M. S.; Abdelkader, E. M.; Hifny Saber, A. (Cairo Univ.). Bull. Fac. Pharm. Cairo Univ., 1: 137-47(1962).

Seeds of Datura innoxia Miller were subjected to different doses of gamma radiation and each sample was separately grown together with a control of untreated seeds. Observations concerning the vegetative growth as well as the alkaloidal content were recorded. Germination was

retarded by exposure to gamma radiation at high doses. Plants sprouting from irradiated seeds were comparatively weak and most of the seedlings obtained from seeds subjected to higher doses were unable to continue growth. The irradiated plants flowered and fruited in a later date than the control especially those growing from seeds subjected to high doses. Irradiation caused an increase in alkaloidal percentage in all the organs of Datura innoxia especially with small doses; bigger doses either produced only a slight increase or even a decrease in comparison with the control. The nature of the alkaloids in the plants sprouting from the irradiated seeds was identical with that of the control plants; the alkaloids found being hyoscine and hyoscyamine as well as traces of unknown alkaloid with higher R_f, in addition to traces of a substance having the same R_f as meteloidine only in the roots. (auth)

35981 PRE-SOWING γ IRRADIATION OF DATURA STRAMONIUM L., DATURA STRAMONIUM VAR INERMIS SAFFORD, DATURA TATULA L. AND DATURA FEROX L. AND ITS EFFECT ON GROWTH AND ALKALOIDS. Karawya, M. S.; Balbaa, S. I.; Hifny Saber, A. (Cairo Univ.). Bull. Fac. Pharm. Cairo Univ., 2: 65-80(1963).

The effects of different doses of gamma irradiation on pre-sown seeds of Datura stramonium, D. stramonium var. inermis, Datura tatula, and D. ferox from a ^{60}Co source on germination, growth, flowering, fruiting, total alkaloids, and the nature of these alkaloids was studied in plants of three successive generations as well as those resulting from irradiated seeds stored for one year. In the first generation, with the increase of dosage of gamma irradiation, the percentage of germination was lowered, the dates of germination, of flowering and of fruiting were delayed; the height of the plants and also the numbers of leaves and flowers per plant decreased. In plants of the second generation and also those produced from irradiated seeds stored for one year, this effect was noticed but in lesser degree. In the third generation, however, the plants were almost similar to those of the control. Gamma irradiation of the seeds generally caused an increase of the alkoloidal content of the plants in the three subsequent generations. However, no effect on the nature and proportion of the alkaloids present in the plants was noticed. (auth)

35982 EFFECT OF X-IRRADIATION ON DNA SYNTHESIS IN EHRLICH ASCITES CARCINOMA CELLS. Sung, Shan-ching (McGill-Montreal General Hospital Research Inst., Montreal). Can. J. Biochem., 43: 859-64(July 1965).

The rate of DNA synthesis in Ehrlich ascites cells measured immediately after x irradiation of 500 R for 6 minutes in vitro showed about 15% reduction. However, if x irradiation was followed by preincubation of the cells, the subsequent synthesis of DNA in the x irradiated cells was markedly inhibited. Under the same condition, the uptake of thymidine-2-^{14}C, uridine-2-^{14}C, adenine-8-^{14}C, and glycine-1-^{14}C, and protein synthesis in the x irradiated cells were found to be almost the same as those in the non-irradiated control. RNA synthesis measured as total RNA was only slightly inhibited. (auth)

35983 THE EFFECTS OF X-IRRADIATION ON PROTEIN METABOLISM OF THE BRAIN. Nakazawa, Shozo (McGill-Montreal General Hospital Research Inst., Montreal); Hara, Takao; Ueki, Komei. Can. J. Biochem., 43: 1091-8(July 1965).

The effects of x irradiation on the metabolism of rat brain, liver, and spleen were studied. ^{14}C-glucose incorporation into protein of the brain of newborn rats was affected significantly by total-body x irradiation (250 R each day for 4 days). ^{14}C-Leucine incorporation into protein of the brain, liver, and spleen of adult rats was also reduced by total-body x irradiation (300 R each day for 4 days). X irradiation of the head (500 R each day for 6 days) affected ^{14}C-leucine incorporation into protein of rat brain and liver, but it did not affect that of spleen. X irradiation in vitro (5000 R) did not have any effect on protein metabolism of rat brain. The mode of action of x irradiation on protein metabolism is discussed. (auth)

35984 STUDIES ON MECHANISM OF REPAIR OF ULTRAVIOLET-IRRADIATED VIRAL AND BACTERIAL DNA IN VIVO AND IN VITRO. Riklis, Emanuel (Yale Univ., New Haven and Nuclear Research Center, Negev, Israel). Can. J. Biochem., 43: 1207-19(July 1965).

The formation of thymine dimers (TT) from adjacent intrastrand thymines by ultraviolet (UV) irradiation in DNA was studied under different conditions. When thymine-2-^{14}C DNA was exposed in quartz tubes to 0.5×10^6 ergs/mm^2 ultraviolet irradiation, two photoproducts were formed: "a" + TT. The concentration formed in dry DNA was only about $1/10$ of that formed in wet DNA. The survival of T_1 phage in the dark in the resistant (uvr^+) and the sensitive (uvr^-) mutants of E. coli K-12 after UV irradiation of the phage in the wet and dry state is markedly dependent on the state of the phage during irradiation. Survival of T_1 phage, when UV irradiated dry, was the same in the sensitive as in the resistant host cells, over a wide range of UV doses, while a marked difference in sensitivity existed when it was UV irradiated wet. Similar survival was obtained also by photoreactivation. These results correspond with the notion that thymine dimers are involved both in photoreactivation and in dark (host cell) reactivation. Thymine-requiring E. coli K-12 cells were mutated to a radioresistant strain uvr^+ (AB 2416) and a radiosensitive strain uvr^- (AB 2419). Irradiation of cells with a dose of 1000 ergs/mm^2, followed by incubation of the cells in the dark in enriched M9 media, stopped by addition of 5% trichloroacetic acid, hydrolysis of the acid-insoluble fraction and the acid-soluble fraction in trifluoroacetic acid at 175°C, and separation of the products by paper chromatography, showed that the two irradiation products "a" + TT, which were formed in the bacterial DNA, are excised from the DNA in the uvr^+ strain and appear in the acid-soluble fraction. No such excision occurred upon incubation of the radiosensitive strain uvr^-. Incubation of the cells under light showed that photoreactivation prevails in the radiosensitive strain, i.e., disappearance of "a" + TT from the DNA, without their appearance in the acid-soluble fraction, while dark reactivation prevailed in the uvr^+ strain, a result that indicates a stronger affinity of the dark reactivating system to UV-irradiated DNA. Cell extracts prepared by breaking the cells in a French press in Tris buffer, pH 7.5, plus 10^{-3} M Mg^{++} plus 10^{-3} M mercaptoethanol showed a similar mechanism; the two irradiation products were excised from DNA by a uvr^+ cell extract and not by a uvr^- cell extract. Extract of uvr^+ cells brought about excision of photoproducts from DNA of the uvr^- cell extract. The results suggest that an enzyme, capable of excising thymine dimers, is present in the radioresistant cell as part of the system of repair of DNA from UV irradiation, and its mechanism is demonstrated, both in vivo and in vitro. (auth)

35985 COMPACT MUTANTS OF APPLE INDUCED BY IONIZING RADIATION. Lapins, K. (Canada Dept. of Agriculture, Summerland, B. C.). Can. J. Plant Sci., 45: 117-24(Mar. 1965).

Natural mutants of reduced tree size, known as spur types or compacts, have recently been found in several apple varieties. These mutants have short internodes in terminal shoots and fewer lateral branches. Consequently, the trees are small, compact, with more spurs per unit of branch length, and bear earlier and heavier than standard trees of the same variety. The natural occurrence of compact mutants suggested that similar mutations might be induced in other varieties, and in 1956 a project was begun, aimed at producing compact mutants by ionizing radiation treatment of selected apple varieties in which such mutants, at that time, were not known to appear under natural conditions. Induction of the compact growth habit in three apple varieties by ionizing radiation is reported. Dormant scions of the apple varieties McIntosh, Spartan, and Golden Delicious were treated with γ rays from a ^{60}Co source at intervals during the period 1959 to 1961. A total of 6095 scions were irradiated. The scions were cut in midwinter, stored, and treated in the spring shortly before grafting. Three dose levels, 3750, 5000, and 7500 rad, were applied

to various lots. The radiation dose required to kill all fully exposed buds in 50% of the scions (LD_{50}) varied with the variety and the year of treatment. Generally, thin scions with large buds were more sensitive than thick scions which usually had small buds. The average LD_{50} values for the three varieties were: 3350 rad in 1959, 4880 rad in 1960, and 6100 rad in 1961, the differences between years being most likely the result of varying storage conditions for scions. The rate of mutation was high. In trees of the McIntosh variety, repropagated from irradiated material, the percentage of total vegetative (tree or leaf) mutants was 9.8 and the percentage of compact mutants 5.2. The compact mutants were characterized by shortened internodes and reduced tree size. Various degrees of growth reduction were induced by the radiation treatment. Most of the compact mutants produced fruit of an undesirable shape, often flattened, irregular, and grooved. However, mutants were selected which combined the desirable compact growth habit with fruit that was characteristic of the variety. It is concluded that ionizing radiation is a promising method of inducing mutants of compact growth in apple. Mutants have appeared with unexpectedly great frequency in the irradiated material. Since in most instances more than one characteristic is affected in a mutant, and since undesirable mutants are in the majority, rigorous and prolonged selection may be necessary to add the compact growth characteristic to an acceptable apple variety. (BBB)

35986 THE CATABOLISM OF URETHAN IN YOUNG MICE OF VARYING AGE AND STRAIN, AND IN X-IRRADIATED MICE, IN RELATION TO URETHAN CARCINOGENESIS. Cividalli, G.; Mirvish, S. S.; Berenblum, I. (Weizmann Inst. of Science, Rehovoth, Israel). Cancer Res., 25: 855-8(July 1965).

The rate of catabolism of urethan, which in newborn SWR mice is about 0.1 × therate found in adults, was shown to increase slowly for the first 10 days after birth and most sharply between the 15th and 20th days. This factor appears to be critical in explaining the greater carcinogenic action of urethan in newborn and young mice. Newborn mice of 4 other strains showed similar low rates of urethan catabolism, though they vary widely in their carcinogenic response to this drug. The rate of urethan catabolism was found to be the same in irradiated and nonirradiated mice, although the former are much more sensitive to urethan leukemogenesis. In these cases, therefore, other factors are responsible for the differences in carcinogenic response to urethan. (auth)

35987 NEOBLASTS LABELED BY TRITIATED URIDINE MIGRATE AND BUILD UP THE REGENERATION BLASTEMA OF SWEET WATER PLANARIES. Lender, Theodore; Gabriel, Andre. Compt. Rend., 260: 4095-7(Apr. 5, 1965). (In French).

Grafts in which the neoblasts are labeled by tritiated uridine were implanted in Planarians that had lost their regeneration power after x-irradiation. The labeled neoblasts migrate from the graft toward the wound, build a blastema, and differentiate to constitute the new tissues. (tr-auth)

35988 SOME OBSERVATIONS ON THE EFFECT OF γ RADIATIONS ON THE EGGS OF HOEMONCHUS CONTORTUS (RUDOLPHI, 1803). Premvati (Univ. of Lucknow, India). Current Sci. (India), 34: 380(June 20, 1965).

Eggs of helminth parasites, Hoemonchus contortus, were exposed to γ radiation from ^{60}Co at a dose rate of 1.3×10^5 R with doses ranging from 5,000 to 50,000 R. Results showed that survival of eggs was inversely proportional to the exposure dose. As the dose was increased mortality also increased, and with a dose of 20,000 R only 47.7% eggs remained viable. LD_{50} was calculated on the basis of 16,000 eggs at each dose. The results also showed that eggs did not become completely sterile even after irradiation with a dose of 50,000 R. (P.C.H.)

35989 CHROMOSOME CHANGES IN RAT EMBRYOS FOLLOWING X-IRRADIATION. Soukup, Shirley W.; Takacs, Eva; Warkany, J. (Univ. of Cincinnati, Ohio). Cytogenetics, 4: 130-44(1965).

A study was made of chromosome changes in rat embryos after exposure to teratogenic doses of x rays. Two methods were used for chromosome analysis: a direct method permitting analysis of chromosomes soon after removal of the embryos from the uterus, and a method in which the embryonic cells were first grown in tissue culture for several days after removal, before they were processed. The direct method proved superior to the tissue culture method for demonstrating early chromosome changes. A half day after irradiation a high incidence of chromosomal aberrations was found which dropped rapidly and returned to almost normal values after several days. (auth)

35990 THE EFFECT OF REPEATED IRRADIATION ON THE FLANK EPIDERMIS OF THE GUINEA PIG. Maggiora, A. (Clinique Universitaire de Dermatologie, Geneva, Switzerland). Dermatologica, 129: 101-10(1964). (In French)

The flank epidermis of guinea pigs was exposed to 1600 R 60 days after a first exposure to 1600 R. Both were made with the following constants: 50 kv, 25 ma, one mm Al filter, three-cm field, 15-cm distance source to skin, and five min and four sec exposure time. A histological study was made of 15 flanks 30 days and 10 flanks 60 days after the first irradiation, and of 25 flanks 30 days and 10 flanks 60 days after the second irradiation. The average acanthosis provoked by a single exposure was 21.8 ± 2.3 units after 30 days and 16.1 ± 2.6 units after 60 days (one unit = epidermal thickness of 2.7 μ). After the second irradiation, the acanthosis was 33.9 ± 5 units after 30 days and 37.6 ± 2.8 after 60 days. The 25 flanks studied 30 days after the second irradiation were divided into three groups and the units of acanthosis determined. In the first group, which had acanthotic epidermis without ulceration or atrophy, the measurement was 3.19 units. In the second group, with acanthosis and atrophied epithelium, it was 20.0. In the third group, with ulcerations, acanthosis, and atrophied epithelium, it was 46.3. A histological study was made 30 days after the first irradiation. In some places, the epidermis appeared normal, except for acanthosis. In other places the epidermis had a spongy appearance. The cells of the middle epidermis increased in volume, had clear cytoplasm, vesiculated nuclei, and presented a marginal hyperchromatosis. The granulation of the granular layer varied greatly. The basal layer appeared with and without lesions. In some regions, the epidermis was completely atrophied. In the acanthotic regions, the proliferated epidermis frequently penetrated into the dermis, accompanied by sebaceous glands and cysts of follicular origin. The dermis generally appeared normal. Histological studies made 60 days after the second irradiation showed no atrophied tissue, less numerous ulcerations, less pronounced lesions, but predominate acanthosis. Most of the epidermis appeared normal. Epithelial proliferations were also less numerous. (BBB)

35991 PRELIMINARY OBSERVATIONS ON RADIOSENSITIVITY OF ALGAE AND FUNGI FROM SOILS OF THE NEVADA TEST SITE. Shields, Lora Mangum; Durrell, L. W.; Sparrow, Arnold H. (New Mexico Highlands Univ., Las Vegas). Ecology, 42: 440-1(Apr. 1961).

To evaluate relative radiosensitivity of soil algae and fungi from the Nevada Test Site, 89 soil samples were exposed to different levels of γ radiation from a ^{60}Co source. Total doses ranged from 2.5 to 2560 kR administered at dose rates varying from 190 to 245 kR/hr. The max exposure was 320 kR for the first series, 1280 kR for the second, and 2560 kR for the third. The soils were taken from the surface and 3- to 6-in. depth within one mile of four ground zeros and in undisturbed control areas. In both controls and treated samples, no difference in radiation injury could be observed between those from ground zeros of two years previously and those from undisturbed vegetation zones. Some soil algae were less susceptible to radiation injury than common fungi of arid soils. Three algal species survived acute exposures of 1280 kR, but the upper range of tolerance for fungi in the same samples was 640 kR. Microcoleus vaginatus, the algal species consistently

showing the highest radioresistance, is the most abundant and widely distributed alga in semi-desert soils. Two other algal species (Phormidium tenue and Synechococcus cedrorum) survived a max of 1280 kR. The higher soil moisture level in the control series is reflected in the isolation of a greater number of fungal taxa and the relatively low radioresistance of all species. In the 3rd series, five species grew in culture following soil dosages of 640 kR: (Stemphylium ilicis, Fusarium sp., Phoma sp., Alternaria tenuis, and Streptomyces sp.). (BBB)

35992 ON THE FERTILITY OF RADIOTHYROIDECTOMIZED FEMALE RATS. Hohlweg, W.; Doerner, G.; Schumann, B.; Spode, E. (Institut fuer Experimentelle Endokrinologie der Charite, Berlin). Endocrinology, 47: 179-83(Jan. 1965). (In German)

Female rats with an average weight of 38 g were thyroidectomized by injection of 500 μC of ^{131}I. The treatment totally destroyed the thyroid parenchyma. Macroscopically the thyroid tissue appeared to be much decreased in size and was a grey-white color. Microscopically there was no active tissue, but only scar tissue and hyaline material. In the hypophysis typical basophilic thyroidectomy cells were found. Eosinophilic cells which produce somatotropin were almost completely absent, indicating total thyroidectomy. In rats 3 weeks old radiothyroidectomy caused a drop in production of growth hormone, resulting in cessation of growth without hindering sexual development. However, fertility of the radiothyroidectomized animals was markedly reduced. Out of 32 female rats only 6 produced an average of 4 young each, and in 2 the young were stillborn. The radiothyroidectomized rats were unable to lactate, but the surviving young were normal. (BBB)

35993 METABOLISM OF GLYCINE-1-^{14}C IN THE NORMAL AND IN THE IRRADIATED RAT. Notario, Antonia; Slaviero, G.; Doneda, G.; Santagati, G. (Universita, Pavia, Italy). Experientia, 21: 264-5(1965).

The metabolism of glycine-1-^{14}C was studied in rats under normal conditions and after exposure to doses of 500 and 1000 R whole-body x radiation. Data are presented from measurements of the content of protein and polypeptide in blood serum and liver. Results indicate that irradiation causes a lowering of the hepatic utilization of glycine. The values of radioactivity of both proteins and polypeptides were reduced after irradiation at both doses used. A similar pattern in the radioactivity of the proteins and polypeptides of the plasma were observed in the same animals. The results are compared with those obtained from studies of labeled cystine metabolism in mice. (C.H.)

35994 LYSOSOMES IN HUMAN CELL CULTURES. KINETICS OF ENZYME RELEASE FROM INJURED PARTICLES. Gordis, L.; Nitowsky, H. M. (Johns Hopkins Univ., Baltimore). Exptl. Cell Res., 38: 556-69 (June 1965).

A subcellular fraction prepared from a heteroploid human cell line had the characteristics of lysosomes in that it contained sedimentable acid hydrolases which could be solubilized by adding Triton X-100. Appearance of soluble acid phosphatase activity during acid incubation of these lysosomes was characterized by an initial rapid rise with no further increase until the third hour of incubation. In addition, sedimentable activity increased, suggesting an alteration of permeability of lysosomes to substrate. Ultraviolet irradiation accelerated the release of acid phosphatase during a 90-min period, but was not characterized by the initial rapid rise of soluble activity observed with acid incubation. The effects of acid incubation and ultraviolet irradiation were temperature dependent, with no significant release of enzyme activity at 4°C. Lysosomes from cells grown with 1.5×10^{-4} M prednisolone released less acid phosphatase during acid incubation. Those from cells grown in concentractions of steroids as low as 2×10^{-6} M were similarly affected, but only during the first two hours of acid incubation. Cells grown with 4×10^{-4} M prednisolone showed inhibition of net protein synthesis and no enhancement of lysosome stability. (auth)

35995 PRODUCTION AND ELIMINATION OF EXCESS DNA IN ULTRAVIOLET-IRRADIATED TETRAHYMENA. Shepard, D. C. (San Diego State Coll., Calif. and Oak Ridge National Lab., Tenn.) Exptl. Cell Res., 38: 570-9(June 1965). (ORNL-P-102)

Individual cells of the ciliate protozoan Tetrahymena pyriformis W were irradiated with ultraviolet light (wavelength 254 mμ). Immediately following the next three divisions, cells were fixed and stained by the Feulgen procedure. DNA content was determined by microspectrophotometry, and incorporation of tritiated thymidine into DNA was assayed by autoradiography. The amount of DNA synthesized prior to the first post-irradiation division was three times normal, whether the cells were irradiated during or following the DNA-synthetic period. A normal amount of DNA was synthesized between the delayed divisions following the first. The excess DNA in irradiated cells was eliminated during several generations in unusually large extrusion bodies, resulting in the return to a normal DNA content after the third division. Macronuclear DNA content appears to be controlled by variation in the size and frequency of the extrusion bodies. (auth)

35996 PARTIAL REVERSAL OF THE ANTI-MITOTIC EFFECTS OF HEAVY WATER BY HIGH HYDROSTATIC PRESSURE. AN ANALYSIS OF THE FIRST CLEAVAGE DIVISION IN THE EGGS OF STRONGYLOCENTROTUS PURPURATUS. Marsland, D. (New York Univ., N. Y.). Exptl. Cell Res., 38: 592-603(June 1965).

The well-known anti-mitotic effects of D_2O are counteracted in large measure by application of suitably selected intensities of hydrostatic pressure. Replacement of 70 per cent or more of the H_2O content of sea water by D_2O immediately stops mitotic activity in cleaving sea urchin eggs, regardless of the stage of mitosis at which the experimental treatment is initiated. The mitotic apparatus remains frozen at status quo, whether in prophase, metaphase, or anaphase, unless and until the eggs are returned to normal sea water within approximately 1 hr, before deterioration occurs. Immersion of the eggs in the deuterated media (70, 80, and 90 per cent D_2O-sea water) was initiated at very early prophase and a sample of each batch of deuterated eggs was subjected to compression six minutes later. Without pressure, almost none of the eggs succeeded in reaching telophase, as judged by the appearance of cleavage furrows; whereas more than 98 per cent, at optimum pressure, displayed definitive furrowing activity and many succeeded in reaching the two-cell stage. The optimum pressure, however, increased as the deuteration increased, being 4000, 4500, and 5000 psi, respectively, for the 70, 80, and 90 per cent degrees of deuteration. Moreover, the percentage of development to morphologically normal swimming blastulae, in specimens restored to H_2O-sea water after 1.5 hr of experimental treatment, tended to parallel the percentage of successful cleavage. A reasonable interpretation of these results would be that pressure, by virtue of its widely recognized solational effect, tends to counteract the hypergelational freezing of the spindle-aster complex. (auth)

35997 STUDIES ON THE ACTION OF FEEDER LAYERS IN CELL CULTURE. Stoker, M. G. P.; Sussman, M. (Univ. of Glasgow). Exptl. Cell Res., 38: 645-53(June 1965).

The action of feeder layers was investigated using x irradiated mouse cells and the BHK21/C13 line of hamster fibroblasts. The feeder effect once established depends on the continued integrity of the feeder cell. It is maximal within 0.2 mm of the feeder cell and is detectable with diminishing effect up to 1.5 mm from the cell. The active principle is non-dialysable. Its action is not limited to the surface of the substrate around feeder cells but diffuses through agar. (auth)

35998 SMALL BLOOD VESSELS AND THE ORIGIN OF PHAGOCYTES IN THE RAT CEREBRAL CORTEX FOLLOWING HEAVY PARTICLE IRRADIATION. Maxwell,

David S.; Kruger, Lawrence (Univ. of California, Los Angeles). Exptl. Neurol., 12: 33-54(May 1965).

In female rats 28 to 30 days old lesions were produced with a monoenergetic beam of 41.6 Mev α particles (10.4 Mev/nucleon). The unique advantage of this method is that the end of particle range is sharp, about 10 μ. Thus, neurons as well as other cortical elements remain essentially intact 10 to 20 μ below the zone of maximal destruction. Another feature is that the maximum of energy release occurs near the end of particle range (the Bragg effect), so that with appropriate doses it is possible to destroy a layer in the middle of the cortex with minimal damage to overlying laminae, producing a laminar lesion. Lesions were made in the supragranular layers of the right striate field of rat cerebral cortex by positioning a 1-mm thick lead shield with a circular 7.2-mm dia aperture over the cranium. Extensive, vascular damage was only prominent in the range of 12 to 30 krad surface dose. Animals were killed from 1 day to 20 months for electron microscopy of the lesions. During the first few days following low-dose irradiation, the single endothelial layer of small blood vessels is thicker than normal. The increase in cytoplasm in these cells is accompanied by augmented numbers of mitochondria, Golgi profiles, free ribosomes, and endoplasmic reticulum. The basal lamina of the endothelial cells are thickened in many cpaillary profiles. Although leakage of plasma proteins through the capillary walls occurs, the endothelial lining and its basal lamina remains intact and the junctions between adjacent endothelial cells appear normal. After heavy doses of irradiation (20,000 or 30,000 rad) vessel wall elements have received lethal doses of irradiation; however, prior to the liquefaction of the irradiated tissue, the endothelial linings are intact. The limited response is in striking contrast to the necrosis in the tissue surrounding the vessels. One day following heavy doses of irradiation the pericytes and surrounding cortical tissue show little indication of receiving a lethal dose of irradiation. Two days following exposure, however, the cortical tissue surrounding the small vessels is greatly disrupted. The only structures intact and unchanged are the endothelium and basal lamina of the small blood vessels. The pericytes hypertrophy and increase in number. The hypertrophied cytoplasm of the pericytes is filled with large cisterns, the nature of which is obscure. (BBB)

35999 A HISTOLOGIC STUDY OF THE EFFECTS OF LOW-DOSAGE IRRADIATION OF RABBIT OVARIES. Moawad, Atef H.; Rakoff, A. E.; Kramer, Simon (Jefferson Medical Coll., Philadelphia). Fertility Sterility, 16: 370-83(May-June 1965).

Following a review of the effects of ionizing radiation on the ovaries of various animals, results of experiments are presented describing gross and histologic changes in ovaries of adult rabbits after 50 to 400 R x irradiation. Gross observations one day to six weeks later showed that in the animals that had a dose of 50 R to one ovary only, there was no significant difference in size or morphologic features between both ovaries. In the animals that had 100 R to one side only, the hyperemia, hemorrhagic cysts, and changes in morphologic characteristics of the genital organs were not significant. In the groups treated with 50 to 100 R to both sides, no changes from pretreatment observations could be noticed other than hyperemia, adhesions, and occasional infection. Microscopic changes indicated that there was no degeneration in the granulosa or theca cells, and no cytoplasmic eosinophilia or pyknosis in the treated ovaries. In the animals treated with 50 R there was no evidence of degenerated follicles in the cortex. A statistically significant increase in the overall percentage of mature forms of follicles in different stages of maturity over the primordial follicles was noted in the ovaries treated with 50 and 100 R as compared to the ovaries on the nonirradiated side. There was no significant difference between the percentage of primordial follicles with intact distinct nuclei and the percentage of those in which the nuclei could not be distinctly identified in control and 50-R treated ovaries. Thus irradiation to the rabbit ovary at a dosage level of 50 R results in a relative increase in the number of growing follicles, whereas at a level of 100 R there is a decrease in the percentage of mature follicles in relation to the total number. At the dose levels of 50 and 100 R, there was no evidence indicative of increased destruction of more mature follicles, but with larger doses such as 300 to 400 R, there was obvious destruction of the graafian follicles. These data therefore suggest that the destructive effects of irradiation depend on dosage, with small doses (100 R) inhibiting follicle growth and larger doses causing follicular degeneration affecting first the larger follicles and later even the younger follicles. These findings are in accord with the numerous observations reported on the effects of low-dosage irradiation to the ovaries of anovulatory women, in which evidence of increased follicular function, ovulation, and pregnancy occurred in a significant percentage within a short time after treatment. (BBB)

36000 MICROSCOPIC AND SUBMICROSCOPIC CHANGES IN THE LIVER DURING RADIATION SICKNESS PROVOKED BY RADIOACTIVE STRONTIUM. Khomutovskii, O. A. (Bogomolets Inst. of Physiology, Academy of Sciences, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR, 11: 208-19(Mar.-Apr. 1965). (In Ukrainian).

Microscopic and submicroscopic liver structure was studied in 175 white rats and 25 porpoises during radiation sickness induced by single and multiple intra-abdominal injections of ^{89}Sr and ^{90}Sr as chlorides. Differences in the quantity absorbed in the hepatic tissue during the first period of radiation sickness appeared to determine the quantitative and qualitative differences of induced morphological changes. Hepatic cell content of DNA and RNA decreased and the amount of fat and glycogen increased during the early period of radiation sickness. Together with the disturbance of the processes of exchange, degeneration of the organs and submicroscopic structures of the hepatic tissues developed: mitochrondria swelled, disorganization of the ergastoplastic membrane occurred, RNP granules enlarged and thickened, and in the nuclei finely dispersed fractions of chromatin thickened. Chronic exposure (0.1 rad/day) prevented the growth and normal processes of degeneration resulting in the appearance of atypical cells in the hepatic parenchyma. The disturbance of the regeneration of submicroscopic structures combined with processes of oxidizing phosphorylation, synthesis of the neutral glycerides, carbohydrate exchange, and synthesis of nucleic acids and albumin is explained by the formation of atypical submicroscopic structures. The atypical organoids produced a disturbance of the glycogen formation function in the hepatic cells. Progressive changes in the walls of the finely dispersed vessels were observed simultaneously. During chronic exposure caused by the presence of ^{90}Sr in the tissues, morphological changes steadily increased. When the intensity of the exposure was reduced, the processes of regeneration increased leading to greater restoration of the parenchymal tissue. (TCO)

36001 STUDIES ON BONE FORMATION DURING TRANSPLANTATION OF AN EXPERIMENTAL OSTEOGENIC SARCOMA. Horie, Kenya (Tachikawa Hospital, Tokyo). Gann., 53: 319-23(Dec. 1962).

Radioinduction of bone tumors is reported and changes in the histologic characteristics of the tumors following transplantation are described. In Wistar rats ^{32}P was administered intraperitoneally at monthly intervals, and three months after the first administration of ^{32}P, methylcholanthrene or benzpyrene was administered intramedullarly in a single dose. Osteogenic sarcomas developed and were successively transplanted in the back of the same strain of rats. The transplanted tumors were examined by routine histologic and roentgenologic methods. On histologic examination the subcutaneously transplanted sarcomas showed variable patterns. Sometimes little or no bone formation was observed in the course of successive subcutaneous transplantations, but bone and osteoid formation was observed in one specimen which represented the 13th generation transplant from a rat treated with ^{32}P and benzpyrene. It showed no osteoplasia on x rays, but proved to be an osteogenic sarcoma on histological examinations,

which showed pathologic bone and osteoid distinctly in some parts. The greater part of the tumor consisted of polymorphic sarcoma cells with giant cells, and mitosis was sometimes observed. Besides the pathologic osteoid and bone formation, hyaline ground substance was seen. Another sarcoma which showed spindle-shaped sarcoma cells or giant cells with mono- or polynuclei and sometimes mitotic figures, and a matrix of hyaline or fibrous ground substance without bone formation, was transplanted into medullary cavity of the tibia of a rat. Four months after implantation radiographic examination showed bone-forming tumor, spicule formation, and pathological fracture. On histological examination it showed osteoplasia not only in the center of the sarcoma but also in the peripheral part outside the periosteum. The sarcoma cells showed a reticular structure besides bone formation, but the reticulin fibers were few. Necrosis and hematoma-like or sinusoid structures were observed in the sarcoma. Metastases in the lung were also seen which indicated distinct bone structure with abscess formation. Thus these two studies of ^{32}P-induced tumors show that the successively subcutaneously transplanted osteogenic sarcoma, which was produced by forming little or no bone, and seemingly appearing as polymorphic cell- or fibro-sarcoma, showed evident osteoid formation in the 13th generation of transplantation; and an osteoplastic sarcoma developed when a nonsteoplastic sarcoma of the same radiogenic origin as the above tumor was transplanted into the medullary cavity of a Wistar rat. This suggests that a sarcoma originating from bone possesses a latent capacity for osteoplasia even if it has lost osteoplastic ability during successive transplantations, and can develop into an osteoplastic sarcoma under certain circumstances. (BBB)

36002 THE INFLUENCE OF DOSE ON THE SPECTRUM OF RADIATION-INDUCED MUTANTS AFFECTING A QUANTITATIVE CHARACTER IN YEAST. James, Allen P.; MacNutt, Mary M.; Morse, Pamela M. (Chalk River Nuclear Labs., Chalk River, Ont. and Canada Dept. of Agriculture, Ottawa). Genetics, 52: 21-9(July 1965).

The influence of radiation dose on the spectrum of heterozygous mutant effects on a quantitative character of diploid yeast was studied. The character was rate of cell division. Populations of homozygous cells were exposed to doses of 0, 25, 75, and 200 ergs/mm^2 of ultraviolet light. Vegetative progeny of individual cells were tested for induced changes in rate of cell multiplication. The dose-effect curve was approximately linear for mutations causing a major reduction in rate of cell division. The dose-effect curves for positive mutants (increased rate of mitosis) and minor negative (decreased rate) were asymptotic or declined at higher doses. It was concluded that the frequency of detectable minor mutant phenotypes induced at higher doses gives a gross underestimate of mutation frequency. (auth)

36003 FURTHER DATA ON THE GENETIC LOADS IN IRRADIATED EXPERIMENTAL POPULATIONS OF DROSOPHILA MELANOGASTER. Sankaranarayanan, K. (Rockefeller Inst., New York). Genetics, 52: 153-64(July 1965).

The genetic consequences of exposure to x rays were studied in experimental populations of Drosophila melanogaster maintained under conditions of relaxed natural selection. Three doses were used (2000 R, 4000 R, and 6000 R) to irradiate the males in every generation. The egg to adult viability was studied. In all the populations, the viability decreased for the first few generations, and then fluctuated at equilibrium levels depending on the amount and the history of irradiation. Three subpopulations were derived, one from each of the chronically irradiated populations, at the total accumulated dose of 120,000 R. When relaxed from radiation, the subpopulations rapidly recovered in about four or five generations to 70 to 75% viability level and remained there. For a given total dose of radiation, the frequencies of accumulated lethals and semilethals vary depending on the number of generations during which the total dose is delivered. Thus, at the cumulative dose level of 120,000 R administered at the rate of 6000, 4000, and 2000 R per generation for 20, 30, and 60 generations respectively, the frequencies of second-chromosome lethals and semilethals in the first two populations were close to 90%, whereas in the third population, it was only 57%. Using statistical techniques devised by Wallace and Madden and by Dobzansky and Spassky, estimates of the variances of the viabilities of the chromosomes and the chromosome combinations were made, and the frequencies of the subvitals computed. The genetic variances of the homozygotes were higher than that of the heterozygotes; the frequencies of subvitals were greater in the heavily irradiated populations than in the others. (auth)

36004 STATUS OF INVESTIGATIONS IN THE BRAZILIAN AREAS OF HIGH NATURAL RADIOACTIVITY. Franca, Eduardo Penna (Univ. of Brazil, Rio de Janeiro); Almeida, J. C.; Becker, Johanne (and others). Health Phys., 11: 699-712(Aug. 1965).

The Brazilian areas of abnormally high background radiation afford excellent opportunities for investigations of long-term consequences of continuous exposure to ionizing radiation in the range of 5 to 100 times the normal levels. A joint program by three institutions was initiated to study some of the physical, radiochemical, epidemiological and ecological aspects of these areas. The human populations are being studied in the Guarapari area where the principal exposures are to external radiation at levels 5 to 12 times normal, and in the food growing area near Araxa, where radiochemical analysis of food and human excreta for ^{226}Ra, ^{228}Ra, and ^{228}Th is under way in order to estimate the human intake of these nuclides. Ecological studies are being conducted on Morro do Ferro, a hill near the city of Pocos de Caldas, where the levels of radiation are as high as 3.2 mR/hr. Alpha and gamma spectroscopies were used to study soil composition and contamination of biota by heavy radionuclides. An intensive survey of flora and fauna is being conducted on a hill and in nearby control areas. (auth)

36005 STUDIES ON THE SYNCYTE FORMATION INDUCED BY X-RAYS IN RICE PLANTS. Katayama, Taira (Kyushu Univ., Fukuoka, Japan). Idengaku Zasshi, 39: 217-21(Oct. 1964).

Cytological observations showed that the giant cells formed in a completely sterile rice plant induced by x rays are syncytes and not coenocytes. No morphological difference that distinguished the syncyte-forming and normal plants was observed, however. Twenty-four chromosomes were counted in the somatic cells of the sterile plant. The cell fusion to form syncytes was found to have started already at the early stage of meiosis; number of nuclei per PMC varied from 0 to 21. Chromosome configurations per nucleus varied from $8_{II} + 8_{I}$ to $60_{II} + 3_{I}$, and the maximum chromosome number counted was about 220. No data on the genetic behavior of syncyte formation were obtained because of the complete sterility of the plant. However, there was a great variation in the size of pollen grains. (auth)

36006 EFFECTS OF RADIATION ON FROG EGGS. I. THE DEVELOPMENT OF EGGS TRANSPLANTED WITH IRRADIATED NUCLEI OR CYTOPLASM. Sambuichi, Hajime (Hiroshima Univ.). Idengaku Zasshi, 39: 259-67 (Oct. 1964).

Frog eggs γ irradiated before insemination developed normally during the early stages, and then most of them became abnormal embryos. From the remainings a few metamorphosed haploid frogs and a few non-viable haploid tadpoles were obtained. The transfers in which the cytoplasm had been irradiated and the nucleus was introduced from a normal blastula cell were very low in developmental capacity, as compared with the control transfers whose cytoplasm and nucleus had not been irradiated. However, two metamorphosed frogs and a tadpole were obtained from among rN transfers. All the transfers in which the cytoplasm was normal and the nucleus was introduced from an irradiated blastula cell did not develop beyond the heartbeat stage, as irradiated blastulae did not. (auth)

36007 EFFECTS OF LOW DOSE X-IRRADIATIONS ON EARLY MOUSE EMBRYOS. Ohzu, Eji (Hokkaido Univ., Sapporo). Idengaku Zasshi, 39: 433-9(Dec. 1964). (In Japanese)

Observations on x irradiated early mouse embryos at different stages after fertilization, with special regard to the incidence of abnormalities, are reported. The mice used were F_1 hybrids between inbred strains, dd/Mk and CBA/Mk, aged nearly 80 days. Virgin females were mated by being placed with males at the ratio of 1 ♂: 1 ♀ during a period from 6:00 p.m. to 9.00 a.m. the next morning. The females with plugs were irradiated at the two different stages after fertilization; 12 a.m. on the 1st day after mating (0.5 day embryo); and 12 a.m. on the 2nd day after mating (1.5 day embryo). X irradiation doses were 5, 15, and 25 R. The number of resorbed fetuses increased in 0.5 day embryos more than that of 1.5 day embryos. The rate of resorbed fetuses was influenced by dosages, but the rate of dead fetuses did not remarkably differ by dosages. A few incidences of exencephalia and polydactylia of the hind foot were obtained in experimental groups. Abnormal fetuses with polydactylous condition on the fore foot were observed in both control and experimental groups, being strikingly high in the irradiated groups. Histological observations revealed that the cartilaginous ossification occurred in the polydactylous foot. It was concluded that the low level irradiation affects the very early mouse embryo. (auth)

36008 THE INFLUENCE OF SEED TREATMENT WITH GAMMA RADIATION ON PLANT YIELD. Molle, Kr. G. (Danish Atomic Energy Commission, Roskilde, Denmark). Intern. J. Appl. Radiation Isotopes, 16: 397-404(July 1965).

The effect of seed irradiation with γ rays on the yield of plants was examined for the following species: Spring barley, spring and winter wheat, winter rye, maize, fodder pea, white mustard, fodder beet, and radish. ^{60}Co was used as the source of radiation, with doses varying from 10 to 20,000 rads. The experiments were run either as pot or as field experiments, with varying growing periods up to maturity. The experimental data included germination percentage and yield of dry matter, as well as other plant characters, e.g., plant height and number of leaves per plant. The dry-matter production of roots was determined in a number of experiments. No increase in yield or in any other character measured could be demonstrated at any of the doses employed, while the higher doses often resulted in yield depression. (auth)

36009 INACTIVATION OF BACTERIOPHAGE T6 IN AN AQUEOUS SYSTEM BY HIGH ENERGY PROTONS. Tanooka, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). Intern. J. Radiation Biol., 9: 1-9(1965).

T6 bacteriophages were irradiated in water by a 218 Mev proton beam, LET of which covers a range from 4.3 to 30 Mev/g cm^{-2} as the beam traverses a stack of samples and absorbers. The total phage inactivation including both immediate and delayed effects was dose-dependent and independent of LET. A separate measurement of the delayed inactivation showed that 240 Mev protons have the same after-effect coefficient as that of 250 kvp x rays. For the direct phage inactivation in a broth suspension, 240 Mev protons also showed the same efficiency as 250 kvp x rays. (auth)

36010 ULTRASTRUCTURAL ALTERATIONS IN X-IRRADIATED SPLEEN. II. REGENERATIVE STAGE. Abdel-Bari, Waguih; Sorenson, George D. (Washington Univ., St. Louis). Intern. J. Radiation Biol., 9: 11-23 (1965).

The recovery process in the spleen after irradiation of the rat consisted of removal of the cellular debris by active phagocytic cells, which was complete by 24 hours after x irradiation. Plasma-cell proliferation was noticed 3 days after irradiation and reached a peak at 1 week and is most probably due to the stimulating effect of x ray. Compensatory extra-medullary hematopoiesis was at maximum at 2 weeks after irradiation, however, the number of megakaryocytes was at a peak 3 weeks after irradiation. Repopulation of lymphocytes began 1 week after irradiation and was complete by 3 weeks. (auth)

36011 THE EFFECT OF WHOLE-BODY X-IRRADIATION ON THE SYNTHESIS OF INDIVIDUAL FATTY ACIDS IN LIVER SLICES FROM NORMAL AND FASTED RATS. Hansen, Heinz J. M.; Hansen, Lis G.; Faber, Mogens (Danish Atomic Energy Commission, Research Establishment, Risoe, Denmark, and Finsen Lab., Koebenhavn Oe, Denmark). Intern. J. Radiation Biol., 9: 25-36(1965).

Using ^{14}C-acetate and ^{14}C-butyrate as precursors, rat-liver fatty acids were synthesized in vitro and assayed by paper chromatography. Whole-body x irradiation induced a change in the synthetic pattern of hepatic fatty acids towards a relatively enhanced synthesis of palmitic acid. X irradiation and fasting seem to have opposite effects on fatty-acid synthesis. X irradiation counteracts the drop in total synthesis and the relatively enhanced synthesis of palmitoleic acid induced by fasting. The relative enhancement of palmitic-acid synthesis observed stands in contrast to the effect of fasting, which specifically decreases the hepatic synthesis of palmitic acid. There is a general similarity between corresponding fatty-acid patterns based on synthesis from ^{14}C-acetate and ^{14}C-butyrate, respectively. (auth)

36012 SERUM TRANSAMINASE IN MICE AFTER WHOLE-BODY X-IRRADIATION AND THE EFFECT OF A CHEMICAL PROTECTOR. Almonte, Teresita J.; Barnes, J. H.; Bautista, S. C.; De La Cruz, B.; Lansangan, Lili; Pineda, Paciencia A. (Philippine Atomic Research Centre, Diliman, Quezon City). Intern. J. Radiation Biol., 9: 37-42(1965).

Mean serum glutomic-oxalacetic transaminase (SGOT) and serum glutamic-pyruvic transaminase (SGPT) values in normal mice were 99.3 ± 4.7 and 43.1 ± 1.1 units/ml respectively. Both showed significant increases during 24 hours following whole-body doses of 500 or 1000 R x rays. Six hours after 1000 R, the mean SGOT value reached 139.9 ± 2.3 units/ml in unprotected mice, but only 122.0 ± 2.5 units/ml in AET-protected. The SGOT increase at 6 hours did not appear to vary linearly with dose, and may show a saturation type response. Therefore AET may protect SGOT-liberating tissues otherwise than by dose-reduction. The degree of uniformity both of the radiation response of mouse SGOT, and of its reduction by AET, suggests that the system may provide a quick way of detecting or comparing radioprotectors. (auth)

36013 STUDY ON THE CONCENTRATION DECAY OF NAD IN LYMPHOSARCOMA-ASCITES CELLS AFTER X-RAY IRRADIATION. Altenbrunn, H.-J.; Steenbeck, L.; Ehrhardt, E.; Schmaglowski, S. (Robert-Roessle-Klinik der Deutschen Akademie der Wissenschaften in Berlin). Intern. J. Radiation Biol., 9: 43-52(1965). (In German)

The NAD-ase in tumor-cell homogenate can be inhibited by nicotinic acid amide; it attacks the nicotinic acid amide-ribose binding of the NAD. Incubation of irradiated tumor cells in medium containing NAD causes a dose-dependent reduction of NAD, which can be demonstrated beginning at 500 R. Determination of the ^{32}P-incorporation of the NAD separated by column and paper chromatography after incubation of irradiated and unirradiated tumor cells shows no difference in incorporation after incubation periods from 2 to 120 min. The decrease in NAD concentration after irradiation of tumor cells may be interpreted as an increase in NAD-ase activity. (tr-auth)

36014 THE INDUCTION OF CHROMOSOME EXCHANGE ABERRATIONS BY IONIZING RADIATIONS: THE "SITE CONCEPT". Read, John (Wakari Public Hospital, Dunedin, N. Z.). Intern. J. Radiation Biol., 9: 53-65(1965).

Wolff and his collaborators have proposed that there are only four sites in the Tradescantia nucleus, each with a radius of about 0.3 μ, within which 2-break aberrations can be formed by x rays or by fast neutrons. In Vicia faba there are two sites. This concept is incompatible with data describing the production of 2-break aberrations by alpha-particles in Vicia faba. The argu-

ments advanced in support of the site concept are criticized. (auth)

36015 EFFECTS OF X-RADIATION ON THE TESTES OF THE LIZARD, UTA STANSBURIANA STEJNEGERI. Dana, Sumner W. (Univ. of Pittsburgh); Tinkle, Donald W. Intern. J. Radiation Biol., 9: 67-80(1965).

Lizards of the species Uta stansburiana stejnegeri were given whole-body doses of x rays ranging from 250 R to 3000 R, and the testes of normal and irradiated lizards were studied. Spermatogonia appear to be the germinal element most sensitive to x irradiation. Temporary sterility is produced by a whole-body dose of 500 R. Degenerating multi-nucleate giant cells and cellular disorganization were most pronounced in animals kept in confined conditions at sub-normal temperatures. Depletion of spermatogonia may be due to inhibition of mitosis in these cells as no definitely necrotic spermatogonia were observed. Sertoli cells appear to be highly resistant to x irradiation; no pathological forms of these cells were found. The formation of spermatozoa from spermatogonia required no less than 12 nor more than 24 days in Uta. The LD50/30 for Uta is between 1000 R and 1200 R. (auth)

36016 CHROMOSOME-EXCHANGE SITES IN TRADESCANTIA PALUDOSA MICROSPORES. Savage, John R. K. (Medical Research Council Radiobiological Research Unit, Harwell, Berks., Eng.). Intern. J. Radiation Biol., 9: 81-96(1965).

The distribution of chromosome-exchange aberrations between cells, induced by radiation in Tradescantia paludosa microspores four days before pollen-grain mitosis, has been investigated. Gamma, x, and neutron radiations given at a variety of dose-rates, and under different environmental gas conditions, are represented in the data. Dicentric plus centric ring types conform to a binomial distribution $(p + q)^n$ with $n = 2.4$, over the whole yield range investigated. If n is equivalent to the average number of sites available for exchange, this is strong evidence that these are pre-determined physical entities. When dicentric and centric rings are considered separately, each type conforms to a binomial with $n = 2.0$. Non-additivity of the n values suggests that differences in probability exist at the two types of site, and a spurious n value arises from pooling. Some possible reasons for this difference between sites are considered. (auth)

36017 EXPONENTIAL SURVIVAL OF THE VISUAL CELLS OF THE RETINA OF MICE IRRADIATED IN VIVO. Lucas, D. R.; Mole, R. H. (Medical Research Council Radiobiological Research Unit, Harwell, Berks., Eng.). Intern. J. Radiation Biol., 9: 97-98(1965).

The highly differentiated and specialized visual cells of the retina of mice appear to give typical exponential survival curves after exposure to x rays in vivo with D_{37} values in the range given by other mammalian cells. The extrapolation numbers (10^3–10^{11}) and the shoulders (D_Q = 1700–3500 rads) are by far the highest yet recorded. There seem to be systematic changes in D_{37}, D_Q and the extrapolation number as differentiation proceeds. (auth)

36018 EFFECTS OF BRAIN LESIONS ON ELECTROENCEPHALOGRAPHIC ACTIVATION BY 35 kvp AND 100 kvp X-RAYS. Cooper G. P.; Kimeldorf, D. J. (Naval Radiological Defense Lab., San Francisco). Intern. J. Radiation Biol., 9: 101-5(1965).

Brief head exposures to 35 kvp and 100 kvp x rays were given to three groups of rats. Electroencephalographic recordings were made on sleeping rats before, during, and after exposure. Exposure to 100 kvp x rays produced, electroencephalographic activation in rats without brain lesions or with lesions of the cerebral cortex, but 35 kvp x rays were much less effective. These results indicate that peripheral sensory stimulation is not essential to the reaction. Lesions of the olfactory bulbs almost abolished the response to x rays, indicating a critical role for this brain region in radiation-induced neural activation. (auth)

36019 EFFECT OF X RAYS ON THE PERMEABILITY OF CONNECTIVE MEMBRANES. van Caneghem, P. (Universite, Liege); Lachapelle, J. M. Intern. J. Radiation Biol., 9: 115-22(1965). (In French)

The permeability for normal saline solution of an irradiated connective tissue membrane of rats varies greatly according to the content of ground substance. Low doses of x rays (some hundreds of roentgens), which act on the mucopolysaccharides, increase the permeability of the membrane. The solution of sodium chloride reduces the permeability of the mesenteric membrane which contains little ground substance. Our experiments failed to show with certainty the reduction of permeability caused by strong doses of x rays (some thousands of roentgens), which had been described by Pospíšil and Dvořáková (1962) on the mesentery of the rat. The difference of the results of the two groups of authors are due to the difference of the structure and composition of the chosen membranes. The action of hyaluronidase and thiomucase does not only change the permeability of the conjunctival aponeurosis, but also its reaction to irradiation. (tr-auth)

36020 HAEMATOLOGICAL EFFECTS OF IONIZING RADIATION IN CANCEROUS MICE. Lockner, D.; Ericson, U.; Hevesy, G. (Karolinska Inst., Stockholm). Intern. J. Radiation Biol., 9: 143-52(1965).

The life-span of erythrocytes of mice bearing solid growing Ehrlich tumors is not influenced by exposure of the animals to 150 and 550 rad ^{60}Co γ radiation as determined with ^{14}C-glycine labeling. ^{14}C-incorporation into hemin is depressed by about 20 per cent after 550 rad caused by bone marrow depression, 550 rad depress hematocrit, hemoglobin and blood volume values, and 150 rad influenced only blood volume. These changes are mainly caused by extravasation and subsequent destruction of erythrocytes, combined with bone marrow depression. Reticulocytes and white-cell values are clearly depressed by 150 rad. Cancerous mice did not show higher radiosensitivity with respect to the parameters studied as compared with normal mice. Cancerous erythrocytes did not differ in in vitro radiosensitivity from normal erythrocytes. (auth)

36021 THE EFFECT OF GAMMA-RADIATION AND CYSTEAMINE ON THE AMOUNT OF 5-HYDROXYTRYPTAMINE IN THE RAT ILEUM IN THE COURSE OF 12 HOURS AFTER IRRADIATION. Varagic, V.; Krstic, M.; Stepanovic, S.; Hajdukovic, S. (Medical Faculty, Belgrade and Inst. for Nuclear Sciences "Boris Kidrich", Vincha Yugoslavia). Intern. J. Radiation Biol., 9: 153-5 (1965).

The amount of 5-hydroxytryptamine in the gut of rats had not changed significantly 2 and 6 hours after gamma irradiation. Gamma radiation significantly decreased the amount of 5-hydroxytryptamine in the intestine of the rats 12 hours after irradiation. The decrease in the 5-hydroxytryptamine content of the rat ileum caused by gamma radiation could be completely prevented by pre-treatment with cysteamine. (auth)

36022 SEQUENCE OF EVENTS IN THE PROCESS OR RADIATION DAMAGE IN A NUCLEI ACID CONSTITUENT. Singh, B. B.; Charlesby, A. (Royal Military Coll. of Science, Swindon, Wiltshire, Eng.). Intern. J. Radiation Biol., 9: 157-64(1965).

Thermoluminescence and electron spin resonance studies of adenine, D-ribose, adenosine, adenylic acids, and polyadenylic acid showed that, after γ irradiation at 77°K, the energy is localized on the heterocyclic base molecule and a single symmetrical E.S.R. line was observed in all samples except D-ribose, which shows a triplet. On warming to room temperature, the E.S.R. spectra from all the samples are changed and resemble that of D-ribose, suggesting a migration of damage to the sugar molecule. It is seen that the addition of sugar and sugar phosphate moieties affects the yield of free radicals at 77°K. In the presence of cysteamine, an asymmetrical E.S.R. signal is observed at 77°K, and the asymmetry at the low-field side of the main spectrum arises due to a line associated with the sulphur atom. All the samples emit light during the period of their warming to room temperature, and the maximum glow occurs at −170°C. The intensity of light

emitted is maximal in the base as compared with that from nucleoside and the nucleotide. All the samples showed ultra-violet phosphorescence in the region 3700 to 6000 Å, and the presence of cysteamine quenched phosphorescence as well as thermoluminescence. (auth)

36023 HISTOLOGICAL CHANGES IN THE LARGER BLOOD VESSELS OF THE HIND LIMB OF THE MOUSE AFTER X-IRRADIATION. Sams, Alice (Westminster Hospital, London). Intern. J. Radiation Biol., 9: 165-74 (1965).

The effects of 2000 R of 200 kvp x rays on the structure of the larger blood vessels of male albino mice are described. Irradiation was delivered to one hind limb of mice either 3 or 12 weeks old. Histological studies show that at 9 weeks after irradiation and thereafter there is an increased incidence of intimal proliferation, fragmentation of the elastic lamina, over-production of elastic tissue, necrosis, hyaline thickening, thrombosis, and production of collagen, in the larger vessels. The implied reduction in efficiency was found to correlate with information obtained by arteriograms (Sams 1963). It is suggested that the direct effect of radiation on the components of the vessel wall and the effect of radiation-induced fibrosis of the surrounding tissues on the vessels were both instrumental in bringing about these changes. (auth)

36024 GROWTH AND VIABILITY OF CARP MARKED WITH CALCIUM-45 AND INFLUENCE OF ^{45}Ca MARKING ON HEREDITY. Kirpichnikov, V. S. Izv. Gos. Nauchn.-Issled. Inst. Ozern. i Rechn. Rybn. Khoz., 51: 255-65(1961). (In Russian)

Radioactive calcium absorbed by carp larva from a $^{45}CaCl_2$ solution with an activity up to 2 mC/l and duration of marking not over 2 hours, does not influence the growth and survival of young fish. No influence on heredity has as yet been observed, but theoretically one may expect it to be very weak. The $^{45}CaCl_2$ solutions of the above mentioned activity may be safely used in fishery research as well as practical fish-breeding, in particular for marking young fish of valuable commercial species, when stocking lakes and reservoirs. (auth)

36025 STUDIES ON CANINE ANCYLOSTOMIASIS: DOUBLE VACCINATION WITH X-IRRADIATED ANCYLOSTOMA CANINUM LARVAE. Miller, T. A. (Univ. of Glasgow Veterinary Hospital, Scotland). J. Am. Vet. Med. Assoc., 146: 41-4(Jan. 1, 1965).

A high degree of resistance to A. caninum was stimulated in dogs 3 to 6 months old by double subcutaneous vaccination with 40-kR irradiated infective A. caninum larvae. Resistance to immunity challenge was revealed by a 90% reduction in worm infection and by the complete absence of hematologic and clinical signs of infection in the vaccinated pups, whereas the control dogs had signs of severe acute ancylostomiasis. Only sterile female hookworms were recovered from the control pups which had been infected with the irradiated larvae, and at no stage before challenge were strongyle eggs detected in the feces of the pups undergoing double vaccination. The vaccinated pups experienced a temporary and slight reduction in packed cell volume (PCV) and hemoglobin between the 10th and 20th days after administration of the 1st dose of irradiated larvae. This reduction was about 10% of the preinfection measurements. The mean PCV and hemoglobin levels of this group increased steadily after the 20th day. In the challenge-control pups, there was severe blood loss, resulting from adult hookworms, and a reduction in hematologic values equivalent to 25 to 30% of these figures at the time of challenge. Mean worm burdens at necropsy, expressed as percentage of establishment of the challenge infection, were determined for the control group (65.9%) and for the vaccinated group (7.1%). The percentage protection found (89%) indicated the percentage of normal worms in the challenge-controls which had failed to become established in the vaccinated pups. The reduction in fecal strongyle egg output in the vaccinated pups compared with that of the control group was of the same order as the reduction in worm establishment. These results and those reported earlier are evidence that the described method of prophylaxis for this disease of dogs may prove highly useful. This method of immunization is likely to be safer than chance exposure of young pups to potentially lethal hookworm burdens in hookworm-enzootic areas. (BBB)

36026 SYMPOSIUM ON ATOMIC ENERGY IN ANIMAL SCIENCE: RADIATION EFFECTS ON GONADAL DEVELOPMENT IN FARM ANIMALS. Erickson, B. H. (Univ. of Tennessee, Oak Ridge). J. Animal Sci., 24: 568-83(May 1965).

Germ-cell radiosensitivity is considered in the period prior to sexual differentiation of the gonad as well as in the pre- and postnatal periods. In the prenatal mammal prior to the sexual differentiation of the gonad, sublethal doses of radiation cause no marked effect on the reproductive capacity of viable offspring. Four days after sexual differentiation (day 14 of gestation), 150 R of γ rays will sterilize the prenatal male rat. The gonocyte of the rat retains this high degree of radiosensitivity until the third day of postnatal life at which time many of the primitive germ cells complete their morphogenesis and become spermatogonia. The quantity of radiation necessary to sterilize the male from this point on is of superlethal proportions. The period of maximum male germ-cell sensitivity in swine and cattle extends from days 50 and 80 prenatally, respectively, to days 70 to 80 postnatally in each species. The bull and boar differ from the rat in that sublethal doses of radiation only diminish their sperm-producing capacities and do not cause sterility. Germ-cell radiosensitivity in the female varies with the stage of the meiotic prophase. On day 15 of gestation, 100 R of x radiation administered to the oogonia of the rat decrease germ-cell numbers to about 15% of control values. The same dose administered on the 17th day of gestation, when many of the germ cells are in leptotene of the meiotic prophase, reduce the number of germ cells to 50% of control. Following irradiation at day 19, with a preponderance of oocytes in zygotene, 90% of the oocytes survive and on the day of birth, with the majority of the oocytes in pachytene, a 60% oocyte survival rate is noted. Species differences in oocyte sensitivity are probably related to the stage in the meiotic prophase at which the oocytes of the various species rest. The morphology of the resting bovine oocyte is typical of pachytene and the morphology of the resting porcine oocyte is typical of diplotene. Both pachytene and diplotene oocytes are comparatively refractive to radiation, thus probably accounting for the radioresistance seen in the oocytes of these species. (BBB)

36027 THE EFFECTS OF ULTRAVIOLET IRRADIATION ON INDUCED FORMATION OF CATECHOL OXYGENASE IN PSEUDOMONAS EFFUSA. Atsuta, Joe; Nozu, Keiichi; Yamagishi, Hideo; Honjo, Ichijiro (Osaka Univ.). J. Biochem. (Tokyo), 56: 192-4(Aug. 1964).

Induced enzyme formation is inhibited by uv and x irradiation. Resting cells of P. effusa M-6 under nutritionally deficient conditions are able to synthesize catechol oxidizing enzyme in the presence of catechol. This situation was used to study the mechanism of inhibitory effects of uv, as cell division does not occur during enzyme formation, when the rapidly metabolizable RNA (mRNA) having nearly the same base ratio as DNA is preferentially synthesized. The effects of uv irradiation on catechol oxygenase formation was examined in the exponential inducing phase. Exposure to uv for 30 or 60 sec stopped immediately the increase in the rate of catechol oxygenase synthesis. Exposure for 30 and 60 sec gave 10^{-3} and 10^{-4}% survival, respectively. The effects of uv irradiation on the synthesis of catechol oxygenase after removal of the inducer were also studied. Synthesis of catechol oxygenase was hardly inhibited by the uv irradiation for 15, 30, and 60 sec, suggesting that the process, in which mRNA and ribosomes act in the formation of enzyme, was scarcely damaged by uv irradiation. Thus, it is likely that the inhibition of the induced formation of catechol oxygenase by uv irradiation is mainly due to the damage in the synthetic process of mRNA. Incorpora-

tion of ^{32}P-labeled inorganic phosphate into RNA prepared with 60-sec irradiated cells was inhibited from 10 to 30% for 3-min pulse time. Significant differences between ^{32}P-labeled RNA prepared from the irradiated and nonirradiated cells were observed from the sedimentation patterns. The data show that the synthesis of mRNA heavier than 16S ribosome RNA is mainly inhibited by 60-sec irradiation. The pattern of mRNA synthesized during catechol oxygenase induction is characteristic of mRNA heavier than 16S. It is concluded that the inhibition of induced formation of catechol oxygenase by uv irradiation does not originate from the uv effects on the coding process of amino acid on ribosomes, but mainly from those on the genetic transcription process from DNA to mRNA. (BBB)

36028 RADIATION EFFECTS ON THE GROWTH RATE AND CELL POPULATION KINETICS OF ACTIVELY GROWING AND DORMANT ROOTS OF TRADESCANTIA PALUDOSA. Van't Hof, Jack; Sparrow, A. H. (Brookhaven National Lab., Upton, N. Y.). J. Cell Biol., 26: 187-99(July 1965). (BNL-8523)

Actively growing and dormant roots of Tradescantia paludosa were exposed to x rays to compare the radiosensitivity of an actively proliferating tissue with that of one which is not active but is potentially proliferative. The level of effect was ascertained by the degree of change in the rate of root growth 4 days after exposure. Cell population kinetics were measured in control and in irradiated roots to determine whether or not a change was produced either in the number of proliferating cells or in the mitotic cycle duration which was sufficient to explain the altered rate of root growth. Nuclear volumes were also measured to provide an estimate of the relative total target size in actively growing vs dormant roots. Tritiated thymidine was used to measure the cycle duration and the proportion of cells synthesizing DNA. The results showed that 184 and 305 R respectively were required to reduce the linear root growth rate to 37% of that of the control for actively growing and dormant roots. Mitotic cycle duration, measured 4 days after x-ray exposure, was the same as in the control. The number of proliferating cells, however, was reduced. The rate of cell production in the irradiated roots was reduced to approximately one-half that of the controls. The average nuclear volumes of active and dormant roots were 733 and 491 μ^3 respectively; thus the difference in the number of roentgens required to reduce growth to 37% of the control can be attributed to the different average nuclear volumes. Therefore, the experiments suggest that part if not most of the differences in sensitivity between an actively dividing and an essentially non-dividing meristematic cell population resides in their different average nuclear volumes. Thus the law of Bergonie and Tribondeau needs to be reinterpreted, since the basic reason for the differences is secondary to whether or not the meristematic cells are proliferating. (auth)

36029 ADOPTIVE TOLERANCE TO SHIGELLA ANTIGEN IN IRRADIATED MICE RECEIVING SPLEEN CELL TRANSPLANTS FROM UNRESPONSIVE DONORS. Friedman, Herman (Albert Einstein Medical Center, Philadelphia, Pa.). J. Immunol., 94: 352-7(Mar. 1965).

An investigation was made of the effect of transfer of spleen cell suspensions, prepared at varying time intervals after induction of tolerance in donor mice, to either normal or lethally x-irradiated recipients. Groups of recipient adult mice, 10 to 12 weeks of age, were exposed to 8000 R using a 250-kv x-ray machine. Mice irradiated 24 hr prior to challenge injection with Shigella antigen were incapable of forming normal levels of anti-Shigella agglutinins during the following 2 to 3 weeks. Whereas mean peak titers of normal mice injected with Shigella range from 1:200 to 1:400, with a max titer at the 7th to 10th day after immunization, x-irradiated mice rarely had titers greater than 1:40 during the first 2 weeks after irradiation. In addition, x-irradiated mice not receiving spleen cell or bone marrow transplants invariably succumbed within weeks. Challenge injection of irradiated recipients with Shigella antigen at various time intervals following spleen cell transfer from Shigella-tolerant donor mice did not result in normal levels of agglutinins, as occurred following transfer of spleen cells from normal or Shigella-immune donors. Irradiated mice receiving unresponsive spleen cells were capable of forming normal levels of antibody to sheep erythrocytes or bovine serum albumin. Adoptive tolerance could not be demonstrated in nonirradiated recipients capable of actively forming antibody to Shigella antigens, either with or without spleen cell transfer from normal, Shigella-tolerant, or Shigella-immune donors. Lack of antibody production by tolerant spleen cell suspensions transferred to irradiated recipients cannot be attributed to irradiation effects in the recipients since normal lymphoid cells transferred to similar irradiated mice under identical conditions were capable of producing levels of agglutinins similar to those obtained in normal mice. Also the immunology competent cell capable of such adoptive tolerance seems to be a generalized phenomenon and suggests that lymphoid cell suspensions from animals tolerant to nonliving antigens do not contain cells capable of forming antibody, either in the original unresponsive host or upon transfer to antigen free recipients. These observations suggest that tolerance is manifested both by an initial lack of specific antibody-forming cells in lymphoid tissue and by an inability to develop responsive cells for an extended period of time following antigenic stimulation in a new host. (BBB)

36030 IRRADIATION EFFECTS ON SPERMATOGENESIS IN THE GYPSY MOTH, PORTHETRIA DISPAR (L.). Rule, H. D.; Godwin, P. A.; Waters, W. E. (U. S. Dept. of Agriculture, New Haven). J. Insect Physiol., 11: 369-78 (Apr. 1965).

These studies are part of program to investigate the effects of γ irradiation on the gypsy moth with the aim of developing this means of sterilizing the insect on a large scale. By treating male pupae older than nine days with 20,000 R, egg viability was reduced to less than 1%, with minimal somatic injury. However, if spermatogenesis occurs in the larval period, it seemed likely that sterilization might be effected by exposure of larvae to much lighter doses. A detailed study of spermatogenesis was made in both normal and irradiated individuals; γ irradiations of 500 to 20,000 R were directed against larvae in instars I to V and pupae. Spermatogenesis occurred in the larval period, and meiotic activity began in instar IV. Fully formed spermatozoa were first observed in instar V. The appearance of gonadal tissues of treated and untreated specimens in the pupal stage is described. All irradiation dosages caused some cytological damage; instar IV larvae exposed to 20,000 R died in seven to ten days. The major gross effects of irradiation were: degeneration of germinal cysts, shattering of sperm bundles within the follicles, plugging of the entrance to the vas deferens by interstitial and other tissue (this occurred with higher doses only), thickening of testes walls and septa and of the vas deferens, and clumping of fat body cells around the testes. One or more of these morphological changes might be related to the sterile condition. Spermatogenesis proceeded most rapidly in late instar III and instar IV. Meiotic division apparently began in the latter instar, and all stages of meiosis were observed in rapid sequence. Irradiation effects should be maximal at this time. (BBB)

36031 A STUDY OF TUMOR TYPES PRODUCED BY ULTRAVIOLET LIGHT IN HAIRLESS AND HAIRY MICE. Epstein, John H.; Epstein, William L. (Univ. of California, San Francisco). J. Invest. Dermatol., 41: 463-73(Dec. 1963).

Experimental production of squamous cell carcinomas, fibrosarcomas, and melanotic tumors by the carcinogenic and cocarcinogenic effects of uv light was studied in two dissimilar strains of mice (pigmented hairless and Swiss albino hairy mice). Chronic uv exposures (a total of 15.34×10^7 erg/cm^2 2800 to 3200 Å, from a hot quartz contact source) were applied over a seven-month period. Other mice with tumors on the posterior half of their backs

produced by a single application of 9,10-dimethyl-1, 2-benzanthracene (DMBA) were also treated with uv. The tumors were not produced by photosensitization by the chemical carcinogen since the uv exposures were initiated four weeks after the single application of DMBA. The hairless mice receiving uv alone (Group I) developed primarily well-differentiated keratinizing squamous cell carcinomas. In Group II of the hairless mice, similar but more malignant-appearing tumors were produced by DMBA initiation followed by uv irradiation. Generally only a minimal fibroblastic response occurred in these two groups of hairless mice. In Group III (Swiss strain albino hairy mice), undifferentiated squamous cell carcinomas with a prominent fibroblastic response predominated. Lymph node metastases occurred in a significant number of the hairless mice but was not seen in the hairy animals. Blue papules 1 to 2 mm in diameter were produced in a high percentage of hairless mice treated with a single application of DMBA. In two of these animals, chronic low-dose uv exposures stimulated the small blue papules to form large melanotic tumors. Histologically the tumors consisted primarily of proliferating, invasive pigment-laden polyhedral cells. It is possible that the presence of dermal and epidermal melanocytes influences the uv effect on fibrocytes. Proliferation of melanocytes in the hairless mice may have a protective function, similar to that proposed for the eqidermal melanocyte in human epithelioma formation, as a free radical quencher and/or a mechanical absorber of the damaging uv rays. Thus differential cellular exposure may be important to the variations in connective tissue response. (BBB)

36032 BIPHASIC CHANGES IN CUTANEOUS EFFECTIVE BLOOD FLOW AFTER U.V. IRRADIATION. Levan, Norman E.; Hyman, Chester; Freedman, Robert; Rohter, Frank (Univ. of Southern California, Los Angeles). J. Invest. Dermatol., 43: 451-2(Dec. 1964).

The effect of uv radiation on blood flow in skin was studied with the aid of ^{22}Na in human volunteers by measuring the removal of a freely diffusible radioactive ion from a local injection site. Sequential changes in clearance of ^{22}Na from intradermal injection sites at various times after uv irradiation were followed. The medial aspect of an arm of each subject was exposed to cold quartz irradiation (principally 2537 Å). The dose of radiation administered caused minimal perceptible erythema in Caucasian subjects beginning at about one hour. Radiosodium in isotonic saline was injected intradermally, and the amount of isotope remaining at the injection site was monitored for 15 min with a scintillation detector, pulse height analyzer, and counting rate meter. The results consistently showed a significant decrease in clearance immediately after exposure to uv irradiation, followed by a return toward control levels at one hour, when minimal erythema became clinically apparent in all subjects. Following the onset of erythema, the subjects showed a significantly increased clearance suggesting hyperemia in the exchange vessels. The clearance rate was still at this high level 6 hr after the initial uv exposure. The decrease in the exchange of solutes in the superficial dermis immediately following irradiation of the skin suggests a decreased nutritional circulation in the superficial dermis, before any visible change. An hour later, clearance returned toward control values; at 3 hr, when erythema was clearly evident, clearance was above normal, and remained elevated when measured at 6 hr. Possible mechanisms for vasoactive responses to uv include direct effects on dermal constituents, either the smooth muscle or endothelial lining of the blood vessels, or the dermal mast cells, particularly those in close approximation to vessels. (BBB)

36033 INFLUENCE OF ULTRAVIOLET LIGHT ON PATCH TESTS. Mohajerin, A. H.; Epstein, Stephan. J. Invest. Dermatol., 44: 213-17(Mar. 1965).

The effect of uv light on plain patch tests in humans and in guinea pigs was studied. Patch tests were performed on 10 patients with contact sensitivities to various chemicals. Positive patch tests were irradiated with a dose of long-wavelength uv light (>3200 Å). Guinea pigs were sensitized to paraphenylenediamine (PPD) and neomycin, and positive patch tests were irradiated after 24 to 48 hr with both longwavelength (>3200 Å) and short-wave (2900 to 3100 Å) uv light. The results demonstrated that irradiation of positive patch tests does not visibly intensify the reaction even when patch tests are done with photodynamic substances. These observations were confirmed by histologic studies in guinea pigs in which no significant differences could be detected between irradiated and non-irradiated patch-test sites when long-wave uv light was used. The amount of long-wave uv light which failed to intensify positive patch-test reactions in these experiments regularly evoked positive photopatch tests in patients with photoallergy to chlorpromazine, promethazine, bithionol, and tetrachlorosalicylanilide. In fact, much smaller amounts often produced photocontact reactions in highly sensitive patients. It was also noted that because of recent observations the assumption of a double sensitivity (both contact and photocontact) in cases of photoallergic contact and drug dermatitis can no longer be maintained. It was demonstrated that in most instances, the assumed plain patch tests in patients with allergic photocontact dermatitis actually are masked photopatch tests, that is, patch tests that have not been deliberately exposed to light but which have been triggered incidentally by unintentional exposure to daylight or fluorescent light. Thus, patch tests, well-shielded against natural and artificial light, remain uniformly negative in patients with allergic photocontact dermatitis, indicating that in these instances the reactions following patch tests which had not been adequately protected from incidental light are an expression of photoallergy, not of plain contact sensitivity. (BBB)

36034 REMOVAL OF CEREBRAL CORTICAL TISSUE WITH NEGLIGIBLE SCAR FORMATION USING A BEAM OF HIGH-ENERGY PARTICLES. Van Dyke, Donald; Janssen, Peter (Univ. of California, Berkeley). J. Neurosurg., 20: 289-95(1963).

Cortical lesions were produced in four young adult cynomolgus monkeys by α-particle irradiation and in three others by surgical excision. The dose delivered to the surface of the brain was >100,000 rad. The monkeys were autopsied at 114, 133, 194, or 350 days after irradiation and 197 days after surgery. None of the monkeys showed gross clinical evidence of neurologic disturbances at any time following treatment. Grossly at autopsy of those irradiated there was heavy scarring of the irradiated dura mater that could not be separated easily from the brain. Microscopic sections showed dense proliferation of fibrous tissue in the irradiated portion of the dura mater and arachnoid. By 114 days after irradiation the cortex showed necrosis of the irradiated area, with invasion of the necrotic tissue by macrophages and capillaries. By 194 days, the organized area of necrosis had disappeared, and a new layer of loose supporting tissue resembling the pia-arachnoid had formed. By 350 days, the base of the lesion was covered largely by a thin layer of glial cells resembling the normal pia mater, and reformation of the pia-arachnoid space over most of the irradiated area had occurred. Scars were found in all surgically operated brains but were not seen following destruction of cortical tissue by radiation. It was shown that blood continues to flow through the small arteries and arterioles that have received doses of radiation far in excess of that needed to kill all cells. Formation of scar is an important factor in development of epileptogenic foci following traumatic or operative injury to the cortex. Hence it is suggested that the offending scar, if it were located on or near the surface of the cortex, might be eradicated by means of this technique without producing new formation of scar. (TCO)

36035 DISTRIBUTION OF NEUTRON DOSE WITH DEPTH. Smith, J. W. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Kerntechnik, 7: 266-8 (June 1965).

The separate components of dose to the body from neutron irradiations are described, together with calculations to determine their variation with depth. Others have at-

tempted experimental confirmation of these calculations, and this work is outlined. (auth)

36036 THE MEASUREMENT OF NEUTRON DOSE. Dennis, J. A. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Kerntechnik, 7: 269-73(June 1965).

Systems of detectors are described for measurement of the dose-rate from neutrons in the presence of gamma rays in the fields of radiobiology and radiological protection. In the former the emphasis is on the measurement of the absorbed dose in tissue and in the latter on the measurement of the dose-equivalent, which is derived from calculations of the absorbed dose produced by neutrons in the human body weighted by the quality factor of the secondary ionizing particles. (auth)

36037 HOMOGRAFT SENSITIVITY REACTIONS IN IRRADIATED HAMSTERS. Ramseier, H.; Streilein, J. W. (Wistar Inst. of Anatomy and Biology, Philadelphia). Lancet, 1: 622-4(Mar. 20, 1965).

The nature of the transfer reaction of homograft sensitivity was investigated using the following animal strains: MHA (albino), CB (agouti), and LSH (agouti) Syrian hamsters; DA and Lewis rats; guinea pigs of strains 2 and 13; and mice of strains C57BL/6, C57BL/10 ScSn, B10.129(5M), CAB, and C3H. MHA hamsters were exposed to 200-kv x rays in a whole-body dose of 1500 rad. This dose led consistently to severe leucopenia and, by about the 6th day, to 100% mortality. Intracutaneous inoculations were given 28-30 hr after irradiation. The hamsters were sensitized by means of orthotopic skin homografts. To study cutaneous reactions in homologous hosts, CB hamsters were sensitized against MHA antigens. Lymph-node cells from these animals, in doses of 10×10^6 and 20×10^6, were then injected into the skin of normal MHA hosts. In normal hosts strong reactions were invariable, whereas, in the irradiated animals, mild reactions only were recorded. Skin homografts from the irradiated animals healed normally and were rejected in the classical manner leaving the hosts highly sensitized. Therefore, the skin itself was still viable and antigenically effective after irradiation. This suggests that the transfer reaction depends on more than simple interaction between the immunologically activated lymphoid cells transferred and isoantigens present in the host's skin. Possibly circulating host cells (lymphocytes) must contribute. The nonreactivity of the irradiated hamsters could then be attributed to the severe leucopenia induced by the radiation. If this were so the inoculation of normal lymphoid cells of the host's own genotype with the transferred lymph-node cells might compensate for the x ray induced deficiency. However, when irradiated MHA hamsters were inoculated with CB lymph-node cell mixed in vitro with equal numbers of normal MHA lymph-node cells, severe cutaneous reactions resulted. Similar reactions were elicited when MHA and CB lymph-node cells from unsensitized animals were mixed in vitro and injected into irradiated MHA hosts. Cellular reaction systems involving alien donor species were similarly investigated: lymphoid cells from immunogenetically dissimilar rats, mice, or guinea pigs, when mixed and inoculated into the skin of irradiated hamsters, provoked much the same reaction as mixtures of hamster cells. All the evidence suggests that this reactivity is attributable to differences in transplantation isoantigens. The inoculation of mixtures of human cells was found to provoke similar reaction. The findings suggest that, under proper conditions, lymphoid cells of any species can initiate cutaneous hypersensitivity reactions. That the reactions are manifestations of cellular rather than humoral immunity is suggested by the finding that none was provoked by immune serum mixed with normal lymphoid cells. (BBB)

36038 EFFECTS OF RADIATION ON VEGETATION. Dewar, M. A. Lockheed Georgia Quart., 2: No. 1, 14-17 (1965).

The effects of radiation of various plant and animal systems in the vicinity of the GNL reactor were investigated. The sensitivity of pines to radiation damage was particularly surprising. The lethal dose for mature trees appeared to be approximately 7500 Rads. However, discoloration, death of terminal buds, and inhibition of reproduction occurred when the pines had received as little as 1000 Rads. Hardwoods were found to survive considerably greater exposures than the pines. Irradiation of the greenbrier produced the most significant results a year after the first major irradiation. This concerned leaf production. In cultivated field studies, varieties of radiosensitive weeds and plants were replaced by varieties of radioresistant weeds and plants in such a gradual manner that almost no damage was noticed. (P.C.H.)

36039 THE EFFECT OF X RAYS ON ADULT HYALOMMA ASIATICUM. COMMUNICATION I. Sidorov, V. E.; Grokhovskaya, I. M. (Inst. of Epidemiology and Microbiology, Academy of Medical Sciences, USSR). Med. Parazitol. i Parazitarn. Bolezni, No. 5, 560-3 (Sept.-Oct. 1964). (In Russian)

Adult ticks (Hyalomma asiaticum) were irradiated with 200, 400, 800, 1,500, 3,000, 6,000, and 12,000 R/min. Each group included 50 males and 50 females. None of the doses was lethal, and none caused any external differences from the controls. Vital activity was not altered. Ticks receiving doses from 200-3,000 R did not lose the ability to suck blood. Copulation took place during sucking. Females in the 3,000 R group did not lay eggs but lived up to 6 months after satiation. Those that received smaller doses laid eggs. The number of eggs deposited was consistently smaller than in the controls. Larvae developed from eggs laid only by females receiving doses up to 800 R. Doses greater than 1,500 R completely destroyed the functions of the ovaries. It was concluded that doses of 3,000 R and above may be used in tick control. (CFSTI)

36040 DEPENDENCE OF THE COURSE OF THE ORAL MUCOSA REACTION IN RADIUM THERAPY OF NEOPLASMS OF THE MAXILLOFACIAL REGION ON THE ABSORBED DOSE OF RADIATION. Pavlov, A. S.; Barer, G. M. Med. Radiol., 10: No. 5, 22-30(May 1965). (In Russian)

Local reactions of the oral mucous membrane are studied during Ra therapy in relation to the value of the absorbed dose. Clinical data are based on observations over 50 patients with diverse localization of the malignant tumor of the maxillofacial region subjected to external distance radium treatment. (auth)

36041 THE INFLUENCE OF IONIZING RADIATION ON THE SEXUAL FUNCTION OF MEN. Milman, L. Ya.; Milman, N. Ya. (Central Scientific-Research Inst. of Roentgen-Radiological Inst., Leningrad). Med. Radiol., 10: No. 5, 65-71(May 1965). (In Russian)

Sexual behavior was analyzed in pertinent literature and in patients seeking medical aid, radiologists with a long service record, and patients given radiotherapy three to eight years prior to the study. It was concluded that low doses of ionizing radiation exerted no direct influence on the sexual activity of human males. (H.G.D.)

36042 THE CONDITION OF THE VESTIBULAR ANALYZER IN PEOPLE WORKING WITH SOURCES OF IONIZING RADIATION. Model, A. A. (Kiev Inst.of Industrial Hygiene). Med. Radiol., 10: No. 5, 71-4(May 1965). (In Russian)

The condition of the vestibular analyzer was studied in 28 men and 19 women, who had been frequently exposed to external irradiation. Of this group, 30 had worked with x-ray units, betatrons, or cyclotrons less than 5 years, and 17, more than 5 years. In some cases the total or the daily radiation dose had exceeded permissible limits. Symptoms of radiation sickness (asthenia, vegetative dystonia, changes in the blood) were observed in 11 subjects; the remaining 36 were considered healthy. Thirty-nine complained of vertigo (various symptoms), usually indicating disturbance in the central part of the vestibular analyzer. Caloric and rotation tests were used to determine the functional condition of the vestibular analyzer. (The caloric test is considered a weak stimulus and rota-

tion, a strong one.) Tests showed various functional disturbances of the vestibular analyzer in 44 subjects, including dizziness and the prevalence of vestibular reactions of the inhibition type (dissociation and excitation types of reactions were observed less frequently). An increased general autonomic reaction to the caloric test was noted in half the subjects. The phase character of these vestibular disturbances was demonstrated: In the first stage, diverse changes of vestibular reactions occur, and in the second stage, reactions of the inhibition type predominate. Experimental results indicate that functional changes of the vestibular analyzer are among the first signs of a reaction to radiation. Weakening of the regulating role of the cerebral cortex is presumed to be responsible for the appearance of vestibular disturbances. (ATD)

36043 RADIATION AFFECTION OF THE MYELOPOIESIS IN MONKEYS. Novikova, M. I. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Med. Radiol., 10: No. 6, 42-6(June 1965). (In Russian)

Hemopoiesis was completely suppressed in monkeys by 540 to 630 R gamma radiation doses. 540-630 R of gamma radiation completely suppressed hemopoiesis in monkeys. During the first 8 days after exposure, leukocyte count in the peripheral blood dropped sharply, but the red blood cells showed no significant abnormalities. From the 9th to the 19th day, suppression of hemopoiesis became more pronounced. The leukocyte count dropped further and the concentration of hemoglobin decreased in the red blood cells. The first signs of recovery to appear were occasional immature cell forms in the red marrow and reticulocytes in the peripheral blood. During the third or restorative period (20th to 60th day) the animals appeared completely healthy, and the peripheral blood indices were more or less normal. It is suggested that these results may aid in discovery of mechanisms underlying the development of radioinduced leukemia and aplastic anemia. (CFSTI)

36044 DOES PROLONGED ADMINISTRATION OF PREDNISOLONE STIMULATE THE BONE MARROW? Fleischer, J. (Medizinische Klinik der Medizinischen Akademie "Carl Gustav Carus"; Dresden). Med. Welt, 16: 919-22(Apr. 18, 1964). (In German)

Bone marrow damage caused by irradiation is the result of both direct and scattered irradiation. Bone marrow damage observed after indirect irradiation may be due to humoral factors. Initially, irradiated bone marrow shows degeneration or depression of function in proportion to the irradiation dose administered, usually without complete recovery. Disturbance of cell formation is accompanied by decreased concentrations of enzymes active in DNA synthesis, with decrease in DPN and ATP concentrations and inhibition of glycolysis and protein synthesis. Results of animal studies indicate that in acute, chronic, isolated, or generalized bone marrow insufficiency, as well as in severe leucopenia, substantial improvement from prolonged administration of prednisolone should not be expected, except when an allergic reaction is involved. In any instance where prednisolone does not produce any improvement in blood cell formation, blood transfusions or vitamin B_6 administration is advisable. Sustained prednisolone administration does not seem to have a specific marrow stimulating effect. 82 references. (BBB)

36045 IMMUNIZATION AGAINST SCHISTOSOMA JAPONICUM IN RHESUS MONKEYS. Hsu, H. F.; Li Hsu, S. Y.; Osborne, J. W. (Univ. of Iowa, Iowa City). Nature, 206: 1338-40(June 26, 1965).

It was previously reported that the inoculation of rhesus monkeys, Macaca mulatta, with cercarial of the Formosan (F) non-human strain of Schistosoma japonicum gives a high degree of protection against a challenge with the Japanese (J) human strain. This approach to the immunization of rhesus monkeys against S. japonicum led to the use of x irradiated cercarial of the J strain (JIR). Results indicated that if sufficient time elapses between the last immunizing inoculation and the challenge, a very high degree of immunity, manifested by a negative finding of eggs in the stools of rhesus monkeys was observed. (F.J.H.)

36046 DIRECT X-RAY INACTIVATION OF THE VIRUSES OF TESCHEN AND TALFAN DISEASES, FOOT-AND-MOUTH DISEASE AND VESICULAR STOMATITIS. Johnson, C. D. (Research Inst. (Animal Virus Diseases), Pirbright, Surrey, Eng.). Nature, 206: 37-9(July 3, 1965).

A comparison was made between the direct x-ray inactivation rates of the following viruses: foot-and-mouth disease virus (FMDV), vesicular stomatitis virus of the Indiana immunological type, and two viruses of the Teschen disease group (the original Teschen strain and the Talfan strain). It was not possible to differentiate between the Teschen and Talfan strains by observation of their rates of direct inactivation by x radiation. Frozen and liquid samples were irradiated and after irradiation the infectivities of the virus samples were estimated by inoculation of series of ten-fold dilutions into groups of 5 to 10 unweaned mice, or by plaque counts of ten-fold dilutions on pig kidney cell monolayers, or on baby hamster kidney cell monolayers. The survival curves of Teschen and Talfan viruses had equal slopes, which were 30% greater than that for the FMDV virus. The slope of the survival curve for the vesicular stomatitis virus was greater than that for the Talfan and Teschen viruses. The sensitive volumes of the viruses were calculated. (M.C.G.)

36047 INFLUENCE OF ULTRAVIOLET IRRADIATION ON OSCILLOPOLAROGRAPHIC BEHAVIOR OF PROTEINS. Kalab, Dusan (Research Dept. of Bioveta, n. p., Ivanovice na Hane, Czechoslovakia). Naturwissenschaften, 52: 185(1965).

Some new data on the effects of UV on a water solution of proteins were presented. Solutions of horse serum albumin and globulin fractions, lysozyme, normal horse serum, and egg white were used in the concentration range from 0.2 to 2.0%. UV irradiation reduced the size of indentations which appeared on the oscilloscope due to a change of capacity of the electrode double layer caused by absorption and desorption of protein molecules at the interface of the mercury drop electrode. The difference found depended on the dose of UV radiation, the concentration of the protein solution, and the protein investigated. (J.S.R.)

36048 EFFECTS OF GAMMA RADIATION ON LEATHER. Kubota, Minoru; Hirano, Toshiyuki; Okada, Ikunosuke (Tokyo Univ.). Nippon Nogeikagaku Kaishi, 39: 123-8(1965). (In Japanese).

The effects of irradiation from a ^{60}Co γ source on leathers and tendon collagen were studied. In the case of irradiation at levels below 10^7R on hide or chrome-, vegetable-, and formaldehyde-tanned leathers, a pronounced reduction of the physical properties, i.e. tensile strength and shrinkage temperature (Ts), was observed but vegetable-tanned leather showed less decrease in the tensile strength than the chrome-tanned leather in spite of the reduction of Ts. The results of the irradiation effects on chrome- and formaldehyde-tanned leather showed that the damage, or the decrease of tensile properties, became greater with the amount of fixation. The effects of irradiation on the fine structure of tendon collagen at the level of 10^7 R were investigated by x-ray diffraction. The equatorial spacings of 4.67 and 12.6 Å were observed in both nonirradiated and irradiated tendon, and a difference from irradiation effects could not be found. It is suggested that the scission of main chain of collagen molecule might be caused at higher dose levels of irradiation. (BBB)

36049 CHROMOSOMAL CHANGES FOLLOWING SURGERY AND RADIOTHERAPY IN PATIENTS WITH PELVIC CANCER. Amarose, Anthony P.; Baxter, Donald H. (Albany Medical Coll., N. Y.). Obstet. Gynecol., 25: 828-43 (June 1965).

Lymphocytes were obtained from the peripheral blood of six female cancer patients treated by Ra, ^{60}Co, surgery, or a combination of surgery and irradiation. These were cultured to obtain metaphase plates that were examined microscopically. Analyses of the cells showed quantitative and qualitative chromosomal damage in cells containing a deviation from the normal complement of 46. Two days after a cumulative dose of 200 R, a definite change in the distribution of the chromosomes occurred. A plateau was

reached two days after a cumulative dose of 400 R had been given and persisted up to four days following a cumulative dose of 1600 R. In cultures taken 35 days after completion of treatment with total dose of 1900 R, and a significant depression of cells with the modal number of 46 chromsomes was observed. This depression was significantly below the plateau seen during treatment. By 123 days after cessation of radiation therapy the per cent of cells with 46 chromosomes returned to the plateau level achieved during therapy. Cultures taken 113 days after the completion of radiation therapy showed 64% of the cells with the modal number of chromosomes, significantly below the preirradiation level of 74%. The following anomalies were seen: translocations of portions of chromosomes to other chromosomes, deficiencies or deletions of portions of chromosomes, double duplication (endoreduplication) of the entire chromosome complement, chromatid and isochromatid breaks, and achromatic areas on one or both chromatids of one or more chromosomes. Anomalous lymphocytes appeared which contained, within an intact cellular membrane, bi-, tri-, and multinuclei, or unequal nuclear components (karyomeres). Quantitative data showed a randomness in the chromosome distribution before treatment, but after treatment had begun there was no longer any randomness. A bell-shaped curve of response was reached during the course of irradiation. Increasing exposure to radiation therapy did not alter the initial response; i.e., a plateau of response was reached. The chromosome imbalance in patients treated with ^{60}Co arose more frequently by fragmentation of the chromosomes, in turn giving rise to a genetic imbalance. The frequency and persistence of abnormal cells after completion of therapy suggests the existence of stem cells with chromosomal damage. These self-perpetuating cells possess the ability to produce by mitosis one daughter cell which will mature and differentiate, while the other daughter cell remains undifferentiated. (BBB)

36050 TUMOR INDUCTION IN A THOROTRAST KIDNEY. Verhaak, F. (St. Ignatius Ziekenhuis, Breda, Netherlands). Oncologia, 19: 20-32(1965).

The term Thorotrast kidney is used to characterize the presence of Thorotrast deposits in kidney following retrograde pyelography with the aid of this contrast medium, a colloidal solution of ThO_2. The occurrence of pyelorenal backflow during the Thorotrast pyelography is the most frequent cause of this condition. A review of the literature revealed one sarcoma and 16 carcinomas have been reported as developing from renal ThO_2 deposits. A new case is presented in which carcinoma of the renal pelvis was diagnosed 24 yr after use of Thorotrast. X-rays showed pronounced filling of the lymph vessels and probably the lymph nodes (from drainage of Thorotrast via the lymph) by opaque material. Also found were deposits of ThO_2 caused by the pyelointerstitial backflow, and intraluminal Thorotrast deposits resulting from pyelotubular backflow. Part of the Thorotrast showed an amorphous appearance. Examination of the patient disclosed a firm, immobile, tender mass in the left upper abdominal region. On exploratory laparotomy, in the left retroperitoneal space, a firm nodular tumor extending beyond the median line was found; the features were those of an inoperable carcinoma. A biopsy specimen was identified as squamous-cell carcinoma. Several weeks later the patient died in pronounced cachexia. Postmortem examination revealed the omentum to be firmly adhesive to the anterior abdominal wall and liver. The posterior gastric wall and pancreas showed extensive adhesions to a large, firm, retroperitoneal tumor mass which included the left kidney and left adrenal gland. This kidney was completely changed into a firm white tumor. On microscopic examination of the tumor in the left kidney it was found that at some sites the squamous-cell structures changed into adenocarcinoma with elongated tubules, lined with relatively high cylindrical epithelium. The metastatic tumor tissue was generally of the squamous-cell type, but sometimes resembled the transitional epithelium of the urinary tract. Microscopic examination disclosed a finely granular substance in both kidneys the features of which corresponded with those of Thorotrast; small focal accumulations of Thorotrast were also seen in liver and spleen. Thorotrast was partly localized around the renal pelvis and along the interlobar, arciform and interlobular vessels. Thorotrast granules were also found in the glomerular spaces and lumina of the remnants of tubules and ducts. The renal parenchyma was almost completely destroyed. Removal af Thorotrast from the body has not so far been feasible; attempts have been made with BAL, Ca EDTA and Ca DTPA. The question remains, moreover, as to whether successful ThO_2 removal after many years would alter the prognosis in these cases. On the basis of the concept that the risk of malignant degeneration increases with a longer presence of Thorotrast, and because such tumor induction does not merely occur sporadically, a patient with a unilateral Thorotrast kidney should be submitted to nephrectomy, provided his general condition permits this and life expectation is sufficiently long. Extirpation of a Thorotrast kidney is acceptable because such a kidney always contains benign pathologic changes, its function is often reduced, and the patient sometimes experiences pain. It is also advisable during such an operation to remove the immediately accessible lymph nodes. The author reviews 13 Thorotrast cases. The fates of these patients since 1958 have given an additional support for expectation of carcinogenesis. In 1961 a renal pelvis carcinoma was found in one of them, 27 years after retrograde pyelography (case is still to be reported in full). This group of 13 patients with Thorotrast kidney (six of which are bilateral) includes three invasive carcinomas and one carcinoma in situ. The need for registration of all patients with Thorotrast deposits is stressed. (BBB)

36051 SOME PROBLEMS OF RADIATION BIOGEOCENOLOGY. Timofeev-Resovskii, N. V. Probl. Kibernetiki, No. 12, 201-31(1964). (In Russian)

The science of biocenology involves, according to V. N. Sukachev, the quantitative determination of the material and energy balance in biochorologic complexes, consisting of the biomass and its habitat. This requires a study of the biosphere and the determination of all elementary structures and phenomena at various levels of complexity. Of the four levels of life on Earth, genotypic, ontogenetic, evolutionary, and biochorologic, the latter is of special interest for biogeocenology. Study of photosynthesis in natural phytocenoses is considered an excellent experimental method for the determination of energy balances. The most accurate method is represented by radiation-biogeocenologic experiments; they include the study of the stimulating effect of low radiation doses on plants. The radiation source, such as fission fragments, may be introduced into the soil; tests were also carried out by studying the effect of the irradiation of seeds by γ radiation before sowing on the phytocenosis of plants and by introducing the radiation source into the water. The build-up of various radioisotopes in the living organisms and the distribution of radioisotopes introduced into the soil between the soil, water and biomass have also been determined and were found to be a reliable tool. Such studies require a continued observation of the effect of the contamination of a portion of the biosphere. Similar examination has been carried out by means of labeled compounds. (132 references) (TTT)

36052 RELATIVE TARGET SIZES FOR THE INACTIVATION OF THE TRANSFORMING AND REPRODUCTIVE ABILITIES OF POLYOMA VIRUS. Benjamin, Thomas L. (California Inst. of Tech., Pasadena). Proc. Natl. Acad. Sci. U. S., 54: 121-4(July 1965).

The rate of inactivation of the transforming ability of polyoma virus has been found to be 55 to 65 per cent of the rate of inactivation of the reproductive ability using four different methods of inactivation. These results have been interpreted to mean that transformation requires the participation of only 55 to 65 per cent as much of the viral DNA as does plaque formation. Inactivating agents included x radiation, ultraviolet radiation, ^{32}P decay, and nitrous acid. (C.H.)

36053 RADIATION TARGET SIZE OF THE LYTIC AND THE TRANSFORMING ABILITY OF POLYOMA VIRUS. Basilico, C.; di Mayorca, G. (International Lab. of Genetics and Biophysics, Naples). Proc. Natl. Acad. Sci. U. S., 54: 125-7(July 1965).

The sensitivity to γ radiation of polyoma virus, assayed for plaque-forming and transforming ability, shows that the radiation target of the transforming ability is about half the size of the target of the lytic ability. The results are consistent with the hypothesis that only part of the viral genome is responsible for the virus transforming activity. (auth)

36054 MECHANISM OF INACTIVATION OF COLIPHAGE T7 BY X RAYS. Freifelder, David (Univ. of California, Berkeley). Proc. Natl. Acad. Sci. U. S., 54: 128-34(July 1965).

When coliphage T7 is x irradiated in inorganic buffer, the number of nonviable particles equals the number of particles which have received a double-strand break in the DNA. If the irradiation is in 10^{-3}M histidine, an equivalent to nutrient broth as a radioprotective medium, only 40 per cent of the nonviable phages contain double-strand breaks. The remaining 60 per cent can be protected by cysteine plus deoxygenation and are probably inactivated by pyrimidine base damage. Individual single-strand breaks are ineffective. (auth)

36055 METASTASES IN THE CENTRAL NERVOUS SYSTEM: TREATMENT BY RADIOTHERAPY AND CHEMOTHERAPY. Windeyer, Brian (Middlesex Hospital, London). Proc. Roy. Soc. Med., 57: 1153-9(Dec. 1964).

Some cases are described to illustrate the use of irradiation in treatment of tumors disseminated to the spinal cord and brain, with a discussion of possible injury to the central nervous system and of radiosensitivity. (BBB)

36056 INHIBITION OF HOMOGRAFT ACCEPTANCE AND HOMO- AND HETERO-GRAFT REJECTION IN CHIMERAS BY RETICULOENDOTHELIAL SYSTEM STIMULATION. Wooles, W. R.; Di Luzio, N. R. (Univ. of Tennessee, Memphis). Proc. Soc. Exptl. Biol. Med., 115: 756-9(1964).

In view of the fact that pre-irradiation-induced stimulation of the reticuloendothelial system (RES) is associated with a lack of acceptance of genetically foreign bone marrow, the effect of RE stimulation upon the survival of lethally irradiated mice bearing apparently successful foreign marrow transplants was evaluated. Male C57BL/6J mice weighing 20 to 25 g were employed as bone marrow recipients and received 800-R whole-body x radiation. Prior to x irradiation, experimental mice received glucan or trypsinized zymosan daily (4 mg/100 g body weight) as a saline suspension until varying levels of RE activity were obtained. The phagocytic activity of the RES was evaluated in irradiated animals by measuring the intravascular removal rate of a suspension of colloidal carbon. Femoral bone marrow was obtained from adult male B6AF$_1$/J donor mice (C57BL/6J × A/J) and suspensions of 5×10^6 viable cells were injected into control and RE-stimulated recipients within two hr after irradiation. Radiation chimeras were male C57BL/6J mice which had received 800-R x irradiation and were transplanted with either heterologous, homologous, or isologous bone marrow. In the glucan-x-irradiated group, no increase in liver weight was observed whereas spleen and lung weight were increased 122% and 110%, respectively. The intravascular removal rate of colloidal carbon was enhanced 2-fold in this group. Hyperphagocytosis in animals which had received trypsinized zymosan represented a 3-fold increase in the colloidal carbon removal rate over the control group. No increase in liver and lung weight was observed whereas spleen weight was increased 130%. Animals subjected to more prolonged glucan administration demonstrated a marked increase in phagocytic activity as indicated by a 6-fold enhancement in phagocytic function. Pronounced RE organ hypertrophy was evidenced by the 24%, 33%, and 153% increase in weights of liver, lung, and spleen. As the functional state of the RES of the animal increased, 30-day survival of lethally irradiated mice transplanted with homologous bone marrow decreased. At normal phagocytic activity, survival was about 85%. As RE activity increased, survival of mice treated with homologous bone marrow progressively decreased until at maximal RE activity, 100% mortality was manifested. Radiation chimeras, bearing successfully transplanted isologous bone marrow, were unaffected by RE stimulation. Administration of glucan to heterologous chimeras was associated with apparent rejection of the transplant as indicated by the subsequent death of all recipients as contrasted to a 30-day survival of 58% in the saline-treated heterologous chimera group. Glucan administration was associated with a 52% survival in the homologous chimera group whereas no mortality was observed in saline-treated homologous chimeras. The lesser degree of mortality observed in homologous chimeras subjected to RE stimulation suggests that the severity of the reaction may be related to the degree of antigenicity of the transplanted marrow. This is supported by the observation that RE stimulation does not effect the survival of isologous chimeras. (BBB)

36057 5-HYDROXYTRYPTAMINE AND ENDOCRINE REACTIONS UNDER STRESS. Fischer, P. Publ. Univ. Offic. Congo Elisabethville, 4: 119-29(1962). (In French)

Adult rats (175 g) were irradiated with 800 R (250 kv, 20 ma, Cu 0.5 mm, at a distance of 50 cm, and 50 R/min. A drop in kidney ascorbic acid (36%) and cholesterol (42%) was observed in irradiated rats vs controls. If the rats were anesthetized with 4 mg Na nembutal/100 g, either before or after irradiation, the decrease in cholesterol was almost completely eliminated. However, the decrease was less in rats anesthetized before irradiation. Rats in which hypophyses were grafted to the anterior cavities of each eye followed by hypophysectomy produced smaller kidneys containing less cholesterol and less ascorbic acid in animals not receiving irradiation. In newborn rats or those receiving morphine, intraperitoneal injections of 5-hydroxytryptamine caused a drop in ascorbic acid and cholesterol in the kidney. (P.C.H.)

36058 ABOUT RADIATION INJURIES OF THE LIVER, KIDNEYS AND THE HEART. Michailov, Vesselin (Institut fuer Fachschulung und Fortbildung der Aerzte, Sofia). Radiobiol. Radiotherap., 6: 313-18(1965). (In German)

Experiments for determining liver radiosensitivity, compared with clinical findings and results of autopsies, justify the assumption the liver is damaged even by small doses of ionizing radiation. In view of previous results indicating an analogous effect of radiation on the heart and kidneys, radiosensitivity of these organs should be re-evaluated. Possible damage to the heart and kidneys should be considered in radiologic planning. (H.G.D.)

36059 THE IMPORTANCE OF MICROROENTGENOGRAPHY FOR THE EXAMINATION OF TUMORS AND RADIATION INJURIES OF THE LARYNX AND OF THE HYOID BONE. Tichonov, K. B.; Rabinovic, R. M.; Simanovskaya, K. B. (Zentrale Wissenschaftliche Roentgen-Radiologische Forschungsinstituts, Leningrad). Radiobiol. Radiotherap., 6: 343-52(1965). (In German)

Using microroentgenography, the structure of the healthy larynx was demonstrated. The laryngeal cartilages get a trabecular structure in their center typifying spongiosa of the bone, whereas compact bone-substance is predominant at the periphery of the ossification zone. In laryngeal tumors cartilage destruction was found in the microroentgenograms as well as an advance of the tumor into the epiglottic region through the elastic fibers of the upper part of the angle of the thyroid cartilage. A destruction of the spongy structure of the cartilage as a result of intense radiation therapy could be demonstrated. Changes of similar kind were found on the hyoid bone lying inevitably in the primary beam when the larynx was irradiated. (auth)

36060 ON THE DEVELOPMENT OF OOCYTES IN THE NAUPHOETA CINEREA (BLATTOIDEA) DURING X IRRADIATION OF THE HEAD. Caprotti, M.; Cioci, M.; Springhetti, A. (Universita, Pavia, Italy). Radiobiol. Radioterap. Fis. Med., 20: 57-74(Jan.-Feb. 1965). (In Italian)

X irradiation of the head of the insect Nauphoeta cinerea changed the development of the oocytes. Exposure to 10,000 R of adult Nauphoeta cinerea or of last-stage nymphs slowed the development of oocytes; 25,000 R radiation stopped the development of oocytes in adult N. cinerea through lesion of corpus allatum, and X irradiation of N. cinerea head from the 5th to the 16th day after molting increased the development of oocytes in adult N. cinerea as if the functions of corpus allatum were increased. (tr-auth)

36061 MUTAGENIC EFFECT OF GAMMA RAYS AND FAST NEUTRONS ON AIR-DRY SEEDS OF WINTER WHEAT. Khuostova, V. V.; Mozhaeva, V. S. (Inst. of Biological Physics, Moscow). Radiobiologiya, 5: 440-5 (1965). (In Russian)

First generation seedlings from γ-irradiated seeds wintered better than those from fast-neutron-irradiated seeds. Chromosome rearrangement in the first mitosis of the rootlets was insignificant with gamma doses up to 500 R. The RBE for 1 Rad of fast neutrons was ~40 compared to 1 R of gamma radiation, as determined by counting the M_2 mitoses. Neutrons produced 5 times as many mutations as γ rays, but both produced some desirable features. (tr-auth)

36062 ENERGY SPECTRA AND LINEAR ENERGY LOSSES IN THE FIELDS OF BETA-RADIATION DEVICES. Aglintsev, K. K.; Kasatkin, V. P. (Khlopin Radium Inst., Leningrad). Radiobiologiya, 5: 459-63(1965). (In Russian)

The average linear energy loss of beta irradiators (^{35}S, ^{185}W, ^{204}Tl, ^{91}Y, and $^{144}Ce + ^{144}Pr$) varied from 0.2 to 4.8 kev/μ. This must be considered in RBE calculations. (tr-auth)

36063 X-IRRADIATION INFLUENCE ON METABOLISM OF GLYCOGEN FRACTIONS IN BRAIN AND LIVER OF RATS OF VARIOUS AGES. Brodskaya, N. I. (Leningrad State Univ.). Radiobiologiya, 5: 465-8(1965). (In Russian)

The brain content of ^{14}C-tagged glycogen of adult 30-day-old x-irradiated rats (200 and 400 R) decreased significantly; 10-day-old animals showed no change. Combined glycogen metabolism in adult and 10-day rats given 400 R decreased sharply but not in 30-day animals. In the livers of the 10-day rats both free and bound glycogen was low; in the adult and 30-day animals the total glycogen did not change although the ratio of free to combined decreased. Both 200 and 400 R increased the glycogen exchange in 10-day rats; irregular variations in 30-day and adult rats were due to individual body sensitivities. (tr-auth)

36064 CHANGES IN BLOOD COAGULATION IN DOGS SUFFERING FROM ACUTE RADIATION SYNDROME (THROMBOELASTOGRAPHIC DATA). Serikova, A. Z.; Makhalova, O. K. (Leningrad Military Medical Academy). Radiobiologiya, 5: 473-6(1965). (In Russian)

Thromboelastographs of x-irradiated (500 R) dogs showed early damage to the hemostatic system. The method was found to be more sensitive than the commonly used coagulation methods. (tr-auth)

36065 INFLUENCE OF IRRADIATION ON ANAPHYLACTIC REACTION OF ANIMALS WITH LOW SENSITIVITY TO ANAPHYLAXIS. Tumanyan, M. A.; Protasova, O. V. (Gamalei Inst. of Epidemiology and Microbiology, Moscow). Radiobiologiya, 5: 478-80(1965). (In Russian)

Wistar rats with a low anaphylaxis sensitivity that were irradiated 7-14 days before or after sensitization showed a higher sensitivity to repeated introduction of foreign protein. The increase in the anaphylactic reaction corresponded to a higher precipitin titer. (tr-auth)

36066 RADIOBIOLOGIC ASPECTS OF THE KIDNEY. Blake, Damon D. (North Carolina Baptist Hospital, Winston-Salem). Radiol. Clin. N. Am., 3: 75-87(Apr. 1965).

Renal radiobiological factors are reviewed, considering the following topics: animal and clinical data on effects of radiation on the kidney, gross and microscopic pathology radiation nephritis, tolerance of the kidney to radiation, treatment technics avoiding renal irradiation, pelvic isodose patterns, and improvement of the therapeutic ratio by oxygenation and fractionation. Conclusions derived from this review of clinical importance are as follows. The kidneys are probably the most radiosensitive of the abdominal organs, from the standpoint of serious or fatal damage. Pretreatment evaluation of renal status should precede any abdominal irradiation in which one or both kidneys have to be included. A minimum study should include recording of blood pressure, urinalysis, and a pyelogram. Signs of renal radiation damage (early or late) include albuminuria, hypertension, and diminished function. When all of both kidneys must be included in the irradiated volume, the dose should not exceed 2300 rad in five weeks, or its biologic equivalent. Shielding of a portion of both kidneys will often avoid clinical radiation nephritis. Renal radiation tolerance is probably less in children and in diseased or congenitally abnormal kidneys. Radiation nephritis can be avoided in most instances through the use of careful treatment planning and techniques, along with proper radiation equipment. Treatment planning should in every case include a body contour drawing made at the level of the kidneys. The position of the kidneys, as determined by pyelograms, as well as the outline of the desired tumor treatment volume, should be entered on the contour. The position of the kidneys should also be indicated on the skin, as a further precaution. If stationary fields are used, field localization films should be obtained for confirmation whenever this is feasible. Any field-shaping blocks or penumbra trimmers that are to be used in treatment should be in place for localization films. For years the standard dose delivery has been at the rate of about 1000 rad tumor dose per week divided into five equal daily doses. There is no experimental or clinical proof that this represents the optimum fractionation; in fact, there are reports that other fractionation programs have been at least as well tolerated with no deterioration in tumor-normal tissue response. Some better correlation with the tumor cell mitotic cycle, for instance, may prove to be advantageous. Treatment of patients while they are breathing oxygen under three-atm pressure appears to be potentially the most feasible means yet in sight for improving the therapeutic ratio. Recommendations are made for long-term follow-up and interval evaluation of renal status on patients whose kidneys have been exposed to radiation (especially those irradiated in childhood or infancy) since manifestations of injury may appear months or years later. (BBB)

36067 THE ACTION OF X RAYS ON CHARA VULGARIS L. I. ABNORMAL MORPHOGENESIS INDUCED BY IRRADIATION. Gillet, C. (Universite de Liege). Rev. Cytol. Biol. Vegetales, 21: 59-76(1963). (In French)

The apexes of C. vulgaris algae were exposed to x ray doses of 1560 to 100,000 R. The doses between were in geometric progression of two. Before and after irradiation normal culture conditions were maintained. The apexes continued to develop, forming lateral whorls with hypomorphoses. Examination of sections of the hypomorphoses showed them to be related to cytocinetic alterations of a cell or group of initial cells. The initial apical cell did not divide, blocking growth of the telome. The initial nodal cells of the telome stopped dividing, decreasing the number of laterals. The apical cells of the laterals were partially or totally inhibited, while lack of cell division in the nodal cells suppressed growth of bracts and cortical filaments. After irradiation, the cortical cells functioned irregularly and the stipule growths were either suppressed or rudimentary. Irradiation also affected the external structure of the cells, causing them to become oddly shaped, to have off-center laterals, and an abnormally elongated apical cell. There were 60 different types of hypomorphoses observed. These were classified according to their degree of teratology, and a spectrum of the abnormal morphology of irradiated C. vulgaris was obtained. In all the hypomorphoses, the cellular symmetry and arrangement were preserved, although modified. There

was no fundamental transformation of hereditary factors. (BBB)

36068 THE ACTION OF X RAYS ON CHARA VULGARIS L. II. DETAILS OF EFFECTS OF IRRADIATION ON THE NUCLEAR DEVELOPMENT AND CYTOLOGY OF THE VEGETATIVE PLANT. Gillet, C. (Universite de Liege). Rev. Cytol. Biol. Vegetales, 21: 77-96(1963). (In French)

The apical ends of telomes were exposed to x-ray doses of 1560 to 100,000 R and cultured under normal conditions. After seven weeks, the plants were examined for abnormalities as a function of the dose received. After 1560 R there was one % hypomorphosis; after 3125 R, 73%; after 6250 R or more, 100%. The radiosensitivity of similar cells which arose from one cell was frequently the same for all. In differentiated cells from one cell, radiosensitivity was greatest in the first cells differentiated. Besides hypomorphosis, irradiation caused malformations, designated α, β, γ, δ, and ϵ. All increased in frequency with increasing radiation doses, up to 25,000 R. Beyond that, no malformations were present. The longer the latent period after irradiation, the more aberrant were the hypomorphoses. The disturbance of apical cell functioning increased as the latent period increased. However, in the 1560- and 3125-R groups, latency permitted a restoration of morphological normalcy in some whorls. In the 6250-R group, there was a decrease in the aberrations of the hypomorphoses. There was no direct relation between the aberrant character of hypomorphoses affecting the lateral whorls' morphology and the nuclear anomalies observed. Abnormal nuclei were apparent in normal whorls, and vice versa. The number of abnormal nuclei was often less in more aberrant whorls. The complete restoration of abnormal nuclei followed, progressively, the restoration of the external morphology of the whorls. (BBB)

36069 EXTRATERRESTRIAL RADIATION. I. BIOLOGICAL STUDIES. Delahaye, R. P.; Tabusse, E. Rev. Med. Aeron. (Paris), 3: 593-7(Jan.-Feb. 1964). (In French)

A review is given of experiments on radiation of galactic or solar radiation. The experiments, done on earth, in planes, in rockets, in balloons, and in satellites, involved the following biological materials: mammals, insects, plants, algae, cell cultures, and bacteria. Results of the experiments are briefly described. (Aerospace Med., 35: (Jan. 1965))

36070 LATE RADIONECROSIS OF THE CHIASMA OF THE OPTIC NERVE AND HYPOTHALAMUS FOLLOWING THE COBALT THERAPY OF THE HYPOPHYSIS AND NO SPACE-OCCUPYING PROCESS. Bignami, Amico; Giuffre, Renato; Riccio, Antonio (Universita, Rome). Riv. Neurol., 33: 709-30(Nov.-Dec. 1963). (In Italian)

The case is described of a young woman given hypophyseal cobalt teletherapy for a complex multiglandular dysendocrine syndrome that had persisted for ten years. Eight months after the treatments a severe cachexia appeared followed six months later by a rapid loss of sight with the early characteristics of a bi-temporal hemianopsia. The patient died a few weeks after a surgical exploration of the chiasmatic region had shown no space-occupying process. Autopsy showed wide areas of recent necrosis in the hypothalamus and the chiasm, the features of which are described. The pathogenesis of delayed radionecrosis of the encephalon is discussed clinically and histologically, and the hypothesis is advanced that this might be considered as an allergic reaction resulting from radioinduced alterations of nerve tissue. (H.G.D.)

36071 THE EFFECTS OF X RAYS ON THE NERVOUS SYSTEM GROWN IN VITRO: MODIFICATIONS IN THE GANGLIONIC CELLS OF CHICK EMBRYOS. Parrini, A.; Pessina, G.; De Dominicis, R.; Buffalini, G. Nori (Universita, Florence). Riv. Patol. Nervosa Mentale, 84: 337-71(Sept. 1963). (In Italian)

The morphology of x-ray induced modifications of nervous cells grown in vitro were studied as well as the extent of the damage to the explants after being exposed to radiation of varying doses. Spinal ganglia of 8- to 10-day chick embryos were grown in a medium made up of chicken plasma, chicken embryo extract, ultracentrifuged ox serum, and Tyrode's solution at pH 7.4 with 2% glucose. The 12- to 15-day cultures were x irradiated, this being the age at which the explant reached the optimum level of thinning and the most ganglion cells attained maturation. The doses used were 50, 100, 200, 300, 500, and 1000 R. The living cultures were observed with a phase contrast microscope, then fixed at various times following the irradiation (12 to 960 hr), and stained by various methods. The results revealed that nervous cells of chicken spinal ganglia grown in vitro react to irradiation with morphological modifications in past reversible and in part followed by the death of the cells. The morphological modifications appeared to be uniform and were reducible to one of two different types. It was concluded that radiosensitivity of ganglion cells grown in vitro is rather high. The characteristics of the nervous cells make it impossible to determine an average lethal dose, but radiosensitivity of the ganglion cells is quantitatively similar to that of all the other types of cells in vitro. Postirradiation morphological modifications of the ganglion cells in vitro are analogous to those observed in various types of human or animal nervous cells after direct (in vivo) irradiation, but these modifications may not be considered to be specific to radiation. The damage caused in some cellular elements is reversible. These reacquire a normal morphology and survival capacity similar to that of the elements of the control cultures. In other cases the damage leads to the death of the cells, and the decrease in the number of cells, following irradiation, varies with the dose administered. The effects of irradiation on the nervous cells in culture disappear with respect to both morphology and numerical decrease in cells between 96 and 120 hr postirradiation. (TCO)

36072 THYMINE PHOTOPRODUCTS BUT NOT THYMINE DIMERS FOUND IN ULTRAVIOLET-IRRADIATED BACTERIAL SPORES. Donnellan, J. E. Jr.; Setlow, R. B. (Oak Ridge National Lab., Tenn.). Science, 149: 308-10(July 16, 1965).

Bacillus megaterium spores labeled with tritiated thymidine were irradiated with monochromatic ultraviolet light, and the DNA of the spores was analyzed for thymine-containing products. No thymine dimers were observed, but three other thymine photoproducts were found. The unknown products of irradiation were produced in vitro by irradiation of DNA that was dried in the presence of various salts. (auth)

36073 BLEPHARISMA INTERMEDIUM: ULTRAVIOLET RESISTANCE OF PIGMENTED AND ALBINO CLONES. Giese, Arthur C. (Stanford Univ., Calif.). Science, 149: 540-1(July 30, 1965).

An albino mutant of Blepharisma intermedium was much more sensitive (on the basis of time to regeneration of transected cells) to short-wavelength uv radiation than the wild type (containing a reddish pigment) from which the mutant derived. In the wild type, absorption of uv light by the pigment present in the outer surface of the cell presumably reduced the intensity of the radiation impinging on the vulnerable interior. (auth)

36074 ABNORMAL IMMUNE MECHANISM IN ALLOGENEIC RADIATION CHIMERAS. Gengozian, Nazareth (Oak Ridge Inst. of Nuclear Studies, Tenn.); Rabette, Barbara; Condon, Charles C. Science, 149: 645-7(Aug. 6, 1965).

Mice were subjected to x rays (950 Roentgens) and injected with isogeneic (isologous) or allogeneic (homologous) bone marrow. Six to 8 months later these chimeras were injected with Salmonella typhi flagellar antigen, and the formation of antibodies resistant and sensitive to destruction by treatment in vitro with 2-mercaptoethanol was determined. The allogeneic chimeras showed almost normal amounts of serum antibody after a third injection of antigen but a relative defect in their ability to synthesize antibody resistant to 2-mercaptoethanol. Apparently control of antibody formation becomes abnormal in the presence of the immunologic tolerance existing between the host and the foreign hematopoietic graft. (auth)

36075 RADIOSENSITIVITY IN PLANTS. VI. EXPERIMENTS WITH AGED WHEAT AND RICE SEEDS. Fujii, Taro; Matsumura, Seiji (National Inst. of Genetics, Misima, Japan). Seiken Jiho, 16: 21-7(Dec. 1964).

Differences in radiation susceptibility between aged and new seeds were examined. Fresh, 1 and 2 year old wheat seeds and fresh to 4 year old rice seeds were irradiated with 7.5 to 40 kR of γ rays. Germination rate and seedling length were markedly decreased in aged seeds. When the radiation was applied to aged seeds, its effects on germination, seedling growth, and survival rate were more pronounced in old than in fresh seeds, increasing with their age. Aging effect appeared even if there was only a difference of one year and changes due to aging might be involved in chromosome aberration or gene mutation. The decrease in germinability due to age was largest in diploid wheat and smallest in hexaploid wheat. We may assume from the results that at a higher ploidy level, we may expect a higher stability not only in respect to radiations but also to the physiological changes caused by aging. (tr-auth)

36076 EFFECT OF RADIOACTIVE COBALT ON WHEAT. I. EFFECT ON SOME MORPHOLOGICAL CHARACTERS. Mohamed, Hosni A. (Egyptian Agricultural Organization, Cairo); Omar, Abdel Aziz M.; El-Barhamtoushy, Mousa N. Tech. Bull., Egypt. Agr. Organ., No. 76, 1-56(Dec. 1964).

Six wheat varieties belonging to three botanical species were exposed to four treatments of ^{60}Co radiation at 5000, 10,000, 20,000, and 30,000 R. The effects of radiation during seed germination, seedling growth, and mature plant stages were studied. With regard to seed germination characters, seedling emergence was delayed by irradiation, which was directly proportional to the radiation dose. The percentage of germination, in general, decreased with increase in radiation dose. For seedling growth characters, the seedling height was activated by lower doses of 5000 and 10,000 R, and diminished by higher doses. Percentage of seedling survival decreased in general with the increase of radiation dose. In Einkorn the percentage was favored by lower doses of 5000 and 10,000 R. With regard to mature plant characters, some characters were not influenced by radiation, while others were deteriorated. The deteriorated characters included decrease in plant height, number of grains per ear, seed set per spikelet, and grain yield per plant and increase in heading period and stem rust infection. Varieties differed in their sensitivity to radiation. (P.C.H.)

36077 EFFECT OF RADIOACTIVE COBALT ON WHEAT. II. INDUCED MUTATIONS. Mohamed, Hosni A. (Egyptian Agricultural Organization, Cairo); Omar, Abdel Aziz M.; El-Barhamtoushy, Mousa N. Tech. Bull., Egypt. Agr. Organ., No. 79, 1-27(Jan. 1965).

During a study on the effects of radioactive cobalt on morphological characters of some wheat varieties, eight mutants were obtained in R_2. These mutants were found in the high treatments of 20,000 and 30,000 R; only the single mutant from Einkorn was obtained from the 10,000 R treatment. The mutants were easily detected and were; a tipped awned ear, erected ear in tall straw, erected ear in short straw, slender straw and delayed ear emergence from Tosson, long ear from Baladi Bahtim, compacted ear from Giza 150 and short straw from Einkorn. The mutants were studied during three successive generations in respect to the morphological characters, yield per plant, grain yield, and reaction to the three rusts of wheat. It was found that the tipped awned mutant from Tosson and the compacted ear mutant from Giza 150 were the most interesting mutants because of their segregation in the succeeding generations. They segregated with respect to awnedness or compactness of the ear and also reaction to rusts. The two mutants were economically important because of the fact that some of the descendant plants were more resistant to wheat rusts compared with the original parents. (auth)

36078 TRANSFER AND MAINTENANCE OF ADOPTIVE IMMUNOLOGIC TOLERANCE TO SHIGELLA ANTIGENS IN IRRADIATED MICE. Friedman, Herman (Temple Univ., Philadelphia). Transplantation, 3: 465-77(July 1965).

Spleen cell suspensions obtained either from young NIH mice tolerant to Shigella paradysenteriae antigens or from normal control mice were transplanted to either nontreated or previously x irradiated non-immunized recipient mice. All recipients were challenged with Shigella antigens at various times after transfer and their sera tested for anti-Shigella agglutinins to detect immunologic competence. Most irradiated mice receiving cells from Shigella tolerant donors did not form detectable anti-Shigella agglutinins following challenge injections, whereas irradiated mice receiving spleen cells from unresponsive or normal donors were capable of forming normal levels of antibodies to sheep RBC and bovine serum albumin. Adoptive tolerance to Shigella could be maintained in irradiated mice receiving tolerant spleen cells for at least 6 to 8 weeks by weekly injections with Shigella antigen. It appears unlikely that unresponsiveness in either tolerant donors or irradiated recipients was due to masking of antibody production by circulating excess antigen. However, a role for persisting intracellular antigen has not been eliminated as a possible factor for establishment and maintenance of unresponsiveness. (auth)

36079 THE SPECIFIC SUPPRESSION OF THE DIFFERENTIATION OF ERYTHROID CLONES IN POLYCYTHEMIC ANIMALS. Liron, Meir; Feldman, Michael (Weizmann Inst. of Science, Rehovoth, Israel). Transplantation, 3: 509-16(July 1965).

A study was made of the effect of transfusion-induced polycythemia on the formation of intrasplenic clones in x irradiated mice injected with bone marrow cells. Polycythemic animals showed a 3-fold decrease in the number of macroscopic clones obtained, as compared to non-polycythemic animals. Microscopic examination of the cell types of the spleen colonies revealed that the suppression effect of transfusion-induced polycythemia was cell specific: no erythroid clones were formed in the spleens of the polycythemic animals. Both cell replication and differentiation of the erythroid lines were completely inhibited. No such inhibition was observed among the granuloid colonies; in fact, an increased incidence of granuloid colonies was found in the polycythemic animals. (auth)

36080 CONTROL OF THE HETEROLOGOUS CORNEAL GRAFT REACTION. Narain, L.; Basu, P. K. (Univ. of Toronto). Transplantation, 3: 576-80(July 1965).

The effects of pretreatment of corneal donor material on the graft reaction was studied. Bovine corneal tissues were treated with repeated freezing, heat, x irradiation, and serum, and then grafted on to rabbits. Repeatedly frozen and heat treated grafts were nonviable in vitro. They did not produce any reaction in the host's eyes and remained clear. Grafts treated by other methods produced reaction. (auth)

36081 RADIATION EFFECTS ON POLYOMA VIRUS. Logan, D. M.; Whitmore, G. F. (Univ. of Toronto, Can.). Virology, 25: 494-501(Apr. 1965).

Radiobiological techniques were used to study polyoma virus development. The experiment consisted of determining a survival curve of the ability of infected cells to produce virus at various times during the virus latent period. Studies using ^{60}Co radiation and this technique with the polyoma T-mouse embryo cell system are reported. Irradiations with ^{60}Co were performed at the following dose rates: for cell survival 320 rad/min; for virus survival 22,000 rad-min; for cellular capacity (1000 rad/min; and for survival curve experiments 1300 rad/min. The cell survival curves appeared to be strictly exponential down to 0.1% survival with a D_0 (dose to give 37% survival on the linear portion of the inactivation curve) of 227 rad. This value, while greater than the average found for mammalian cells is consistent with the values reported for other tissue culture cell strains. The virus had a D_0 of 2.82×10^5 rad. When the medium was supplemented with a radical scavenger such as fetal calf serum, the radiosen-

sitivity was decreased and reached a max D_0 of 4.09×10^5 rad. Thus, the virus alone is very radiation resistant. In contrast, the cellular capacity had a D_0 of 5440 rad. Infectious complexes of virus infected cells had a D_0 after infection of 7800 rad. This value increased progressively during the eclipse period and after 19 hr approached the value for free virus. These differences are interpreted as changes in the capacity of the host cell during the eclipse period of virus maturation. The decrease in sensitivity with time is assumed to reflect an effective decrease in target size in the cell as various cellular functions are completed and no longer required. The radiation dose required to inactivate polyoma T virus is extremely large in comparison with that required to inactivate some other animal viruses, which is probably a reflection of the small amount and double-stranded nature of the viral DNA. (TCO)

36082 SENSITIVITY TO X RAYS AND ULTRAVIOLET LIGHT OF INTRACELLULAR PHAGE α. Donini, P.; Epstein, H. T. (Brandeis Univ., Waltham, Mass.). Virology, 26: 359-67(June 1965).

The sensitivity of α-infected Bacterium megaterium cells to x rays and uv radiation was studied. Immediately after infection the sensitivity to uv and x rays was the same as that of the free phage. The appearance of an oxygen effect showed that DNA was responsible for the abnormal x-radiosensitivity. During the eclipse period the uv sensitivity of the infected cells did not change, whereas the x-ray sensitivity decreased progressively so that at 20 min after infection the complexes were about 40 times more resistant than free phage. Toward the end of the eclipse period the oxygen effect disappeared. It is suggested that the repair mechanism is induced by the entering phage DNA. (TCO)

36083 POSSIBILITY OF PRESERVING THE INTEGRITY OF DNA AFTER IN VIVO IRRADIATION BY IONISING RADIATION. II. INHIBITION OF DEGRADATION OF DNA AFTER GAMMA IRRADIATION BY MEANS OF THEIR METABOLITES OF THE KREB'S CYCLE. Kos, E.; Drakulic, M. (Inst. Ruder Boskovic, Zagreb). Vojnosanit. Pregled, 21: 89-91(Feb. 1964). (In Serbian).

Depolymerization of bacterial DNA, possibly by deoxyribonuclease, occurs when the cells are irradiated with 16,000 R doses of x rays. Attempts were made to inhibit this enzyme action in experiments using ^{60}Co γ radiation given the same dose (16,000 R) at a dose rate of 1333 R/min. The effects of some metabolites of the Krebs' cycle, Versene (a chelating agent), and Mg^{++} ion on the degradation of DNA caused by irradiation in Escherichia coli B were studied. High concentrations of citrate, succinate, and glutamate added to the acetate buffer in which cells were inoculated after irradiation inhibited almost completely DNA synthesis in the control cultures and the DNA degradation in irradiated cultures. Lower concentrations of succinate and glutamate (10^{-3}M) as well as Versene in the same concentration inhibited degradation of DNA partially. The presence of Mg^{++} ion stimulated the degradation of DNA, whereas the chelating agent had the opposite effect. These results are in accord with the known ability of divalent cations to activate deoxyribonuclease, the chelating agent acting to remove these ions from the enzyme degrading DNA. (BBB)

36084 RESULTS OF SYSTEMATIC UROLOGICAL STUDIES OF CARCINOMA OF THE UTERINE NECK OVER TWO YEARS AT THE UNIVERSITY WOMEN'S CLINIC, LEIPZIG (580 CASES). Dietzsch, Joachim; Schlegel, Charlotte; Weise, Ursula (Universitaets-Frauenklinik, Leipzig). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe, 12: 175-8(1963). (In German).

Results are reported on treatment of 580 cervical carcinoma patients of whom 363 were treated by irradiation, 70 by surgery, and 147 by a combination of the two procedures. In the cases studied there was no increase in the number of urinary tract injuries after irradiation treatment, but a considerable number of the patients did develop these symptoms. This emphasizes the significance of systematic urological control studies such as excretion urograms in the postirradiation period. (TCO)

36085 HUMAN GENETICS AND PUBLIC HEALTH: SECOND REPORT OF THE WHO EXPERT COMMITTEE ON HUMAN GENETICS. World Health Organ. Tech. Rept. Ser., 282: 38p.(1964).

World-wide aspects of genetic disease are discussed, with a review of the increasing importance of mutagenic agents in man's environment on the incidence of such disease. The major external influences which can increase the mutation rate include ionizing radiation and chemical mutagens. To what extent either of these influences is, at present, increasing the mutation rate above the natural level is not certain. However, irradiation is known to produce mutations in all organisms so far studied and there is no reason to believe that man is an exception. Studies in mice provide a rough picture of the extent to which the mutation rate may be increased by irradiation. Attempts have been made to estimate the order of magnitude of the additional burden imposed on a population as a result of exposures to various levels of radiation. Also discussed is the question of genetic hazards from irradiated foodstuffs. Some preliminary data in fruitflies suggest a possible increase in mutation rate after feeding with irradiated food. Since extensive research is at present being undertaken on preservation of food by irradiation for human consumption, further work is needed to see whether such food is likely to be a source of mutation in man. A third possible mutagenic factor discussed is temperature. That elevated temperature may sometimes increase germinal mutation rates has been shown for certain experimental organisms such as fruitflies. It is important for every country to achieve the best possible control of mutagenic agents, whether physical, such as x rays and other ionizing radiations, or chemical. The organization and equipment of health services and the training of medical personnel should be adequate and appropriate for these tasks. The responsibilities and authority of health services should be such as to ensure the development and application of scientifically sound principles and recommendations with regard to mutagens in public health practice. The recommendations which have been in the field of radiation protection are reviewed. Detailed recommendations on radiation protection have been made by the International Commission on Radiological Protection. The elimination of unnecessary exposure of the gonads to radiation is a task that calls for the collaboration of everyone concerned with public health. In some cases, effective measures are simple and practical. For instance, thoracic x-ray surveys carried out on a large scale in some countries for the detection of tuberculosis may in some cases submit large fractions of the population to abdominal and gonadal irradiation which could be avoided by installation of simple devices on the x-ray machines employed. It is concluded that genetic well-being must be considered in the context of other factors that contribute to human welfare, and sometimes short-term objectives must be balanced against long-term objectives. (BBB)

36086 LATE INJURIES AFTER THOROTRAST ADMINISTRATION WITH SPECIFIC REFERENCE TO THOROTRAST PYELOGRAPHY. Brauer, Karl Heinrich; Gabsch, Hans Christian; Hennig, Konrad; Moench, Lothar (Pathologisches Institut der Medizinische Akademie, Dresden, Ger.). Z. Ges. Inn. Med. Ihre Grenzgebiete, 19: 759-64 (Oct. 1, 1964). (In German)

Thirty yr after a patient had been subjected to retrograde Thorotrast pyelography large amounts of Thorotrast were still detectable in various portions of the reticuloendothelial system. The presence of Thorotrast could be demonstrated in kidney by means of autoradiography, as well as by direct measurement of emitted γ radiation. Microautoradiographic studies of the retroperitoneal lymph nodes, spleen, and liver showed many α tracks. The greatest amounts of Thorotrast were detected in the kidney pelvis, and lesser amounts were observed in the kidney parenchyma. In decreasing order of concentration were lymph nodes, spleen, and liver. The most extensive deposits were found in chronically inflamed areas of tissue, scarified tissue, or within necrotic areas. There was considerable localization perivascularly, in vessel walls, and along the lymph vessels. Damage in these areas consisted of fibrinoid wall

necroses, with hemorrhages and some hyalinization. In spite of the long survival period since the Thorotrast was administered, there were no evidences of malignancy detected. The patient died of suppurating pyelonephritis after several massive hematurias. (BBB)

36087 THE INFLUENCE OF EXTRACELLULAR UV IRRADIATION OF T_2 PHAGE ON THE REPLICATION OF ITS DNA. II. THE CONTENT OF DAMAGED GENOME IN SINGLY INFECTED CELLS. Koelsch, Eckehart (Universitaet, Cologne). Z. Verergungslehre, 96: 175-89 (1965). (In German)

Phages inactivated with uv light lose their ability to multiply in singly infected cells. Further data on this phenomenon were sought by investigating the DNA replication of T2 phage in singly infected cells; the thymine-requiring mutant Escherichia coli B-3 was used as a host. These experiments were made to determine whether damage to gene function suffices to explain the phage-killing action of uv. If an additional type of damage exists directly inhibiting replication, the synthesis of phage DNA should be blocked even in cells where the early phage functions can be carried out. Under the assumption that the target size of early function is less than 60% of that of phage survival, the reported results provide evidence for the existence of damage directly inhibiting replication. Single infection of E. coli B-3 with an uv-irradiated phage does not immediately kill the cell. The phage gene controlling thymidylate synthetase allows the synthesis of bacterial DNA to continue for a certain time. This observation is discussed in connection with the metabolic changes in the bacterium after phage infection. It was concluded that injury to the DNA-replicating mechanism is sufficient to explain the results. (BBB)

36088 PROBLEMY RADIATSIONNOI BEZOPASNOSTI KOSMICHESKIKH POLETOV. FIZICHESKIE I BIOLOGICHESKIE ISSLEDOVANIYA S PROTONAMI BOL'SHIKH ENERGII. (Problems of Radiation Safety of Cosmic Flights. Physical and Biological Investigations of High-Energy Protons). Nefedov, Yu. G. (ed.). Moscow, Atomizdat, 1964. 240p.

Problems of radiation safety during space flight discussed are: characteristic radiation effects and permissible levels of irradiation; proton dosimetry and shielding measures; biological effects of 510 Mev protons during acute and chronic exposure; effects of 126 Mev protons on the corneal epithelium in mice; and effects of 510 Mev protons and 180 kv x rays on genetics and on the vestibular analyzer. RBE is considered for x radiation and 510 Mev protons. Prophylaxis and therapy of injuries from 510 Mev protons are included. (R.V.J.)

36089 THYROID ALTERATIONS DUE TO IRRADIATION. Vickery, Austin L. Jr. (Massachusetts General Hospital, Boston). p. 183-205 of The Thyroid (International Academy of Pathology Monograph No. 5), edited by J. Beach Hazard and David E. Smith. Baltimore, Williams & Wilkins, 1964.

Effects of irradiation on the structure and function of the human and rat thyroid are reviewed, with emphasis on internal radiation from ^{131}I. The structural alterations are discussed on the basis of lethal and sublethal damage. The lethal doses of radiation result in replacement of the thyroid with scar tissue within several weeks. Sublethal radiation exposure of thyroids receiving radiotherapy attenuate rather than completely destroy gland function. The most conspicuous cytologic changes following sublethal doses of irradiation are persistent cellular hypertrophy and nuclear abnormalities. The increased cell height and nuclear atypicalities may persist for many years after irradiation. Radiation can produce changes in thyroid function without structural alterations. The hypothesis is presented that irradiation may impair the mechanism of cell proliferation but not the ability of the cell to undergo hypertrophy, as suggested by the following experimental and clinical observations: (1) the impairment of irradiated rat thyroids to gain weight after stimulation by thiouracil or low iodide diet, while showing pronounced individual cell enlargement; (2) the persistence of cell hypertrophy in the remote post-irradiation phase; (3) the rarity of the development of regenerative thyroid nodules in patients treated with radioiodine; and (4) the low recurrence rate of hyperthyroidism in patients with diffuse goiters receiving ^{131}I therapy. The postirradiation nuclear abnormalities probably represent a radiation-induced inhibition of cell division as indicated by the following observations: (1) the accentuation of atypical nuclei in irradiated rat thyroids by attempts to stimulate cell division with the administration of thiouracil or a low iodide diet; (2) the suppression of the appearance or prominence of abnormal nuclei in irradiated rat thyroids by either hypophysectomy or the administration of thyroxine; and (3) an increased DNA content of irradiated thyroid cell nuclei, suggesting that atypical nuclear forms represent the result of attempted but thwarted cell division. Early fears that radioiodine treatment might lead to thyroid malignancies have not been substantiated. The confirmed higher incidence of childhood thyroid cancer after irradiation to the neck area during infancy or early childhood may be attributable to an increased sensitivity to radiation of thyroid cells under active growth stimulus. Use of ^{131}I to treat thyroid cancer is also reviewed. (39 references) (BBB)

36090 INCORPORATION OF NUCLEOTIDES TO POLYNUCLEOTIDES BY GAMMA RADIATION. Jimenez, R.; Toha, C. J. (Universidad de Chile, Santiago). pp 13-18 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington. D. C., Pan American Union, 1965.

When mixtures of ^{14}C-labeled mononucleotides and polynucleotides are gamma irradiated with a total dose of about 10^5 R (approximate radiation rate of 200 R/min) the labeled polynucleotides obtained do not lose their radioactivity by dialysis. If these labeled polynucleotides are chromatographed on DEAE resin paper, they remain in the origin of the chromatogram, and after hydrolysis with KOH or ribonuclease are displaced in the paper with an Rf equal to that of the mononucleotides. The authors also describe the phosphodiesteric union between the polynucleotide and the mononucleotide incorporated into it by gamma radiation, and suggest the possible importance of this reaction on induced mutations and tumors by ionizing radiation, as well as on repairing the radiation damage in nucleic acid of cells. (auth)

36091 STREPTOMYCIN INHIBITION OF A MODERATED PHAGE MULTIPLICATION IN STREPTOMYCIN-RESISTANT STAPHYLOCOCCUS ALBUS. Caldas, L. R.; Elias, C. A.; Barbosa da Cruz, W.; Flores da Cunha, M. (Universidade do Brasil, Rio de Janeiro). pp 31-8 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

The effect of streptomycin on the moderated phage biosynthesis of the Staphylococcus albus lysogenic system was investigated using a system that consists of two bacterial strains, P(ω)/sr and W_s/sr, both of which are streptomycin-resistant. The first is the lysogenic strain carrier of the prophage (ω), and the latter the sensitive strain to the phage liberated by the P(ω)/sr. It is demonstrated that the antibiotic blocks the multiplication of the ω phage in the W_s/sr bacteria. However, when the ω multiplication is induced by ultraviolet irradiation of the lysogenic bacteria P(ω)/sr, it becomes evident that this antibiotic does not hinder the multiplication process. On the basis of experiments made with the incorporation of amino acids and carbon-14 labeled pyrimidine bases, the mechanism of the streptomycin effect is described. (auth)

36092 ULCERONECROTIC ORAL LESIONS PRODUCED IN THE HAMSTER BY IRRADIATION. Mayo, J.; Carranza, F. A. Jr.; Cabrini, R. L. (Comision Nacional de Energia Atomica, Buenos Aires and Universidad de Buenos Aires). pp. 93-6 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

Total-body x irradiation with 700 or more rads produces

ulceronecrotic oral lesions in hamsters which start in the gingival area and extend to other areas of the oral mucosa. These lesions are similar to those produced by total-body irradiation in man and monkey and have not been observed in rats or mice. Irradiation of the head produces erosive and hemorrhagic lesions in the tongue of hamsters. Parenteral administration of chlortetracycline and chloramphenicol completely prevents the development of oral lesions even in animals which receive lethal doses of total irradiation. Antibiotics are more effective than cysteamine and bone marrow in the prevention of these lesions. In the case of head irradiation cysteamine proved more effective than antibiotics. The reported findings suggest that in oral lesions produced by acute total irradiation the bacterial factor plays a primary role in the presence of body defenses reduced by irradiation. (auth)

36093 STUDIES ON THE OFFSPRING OF BRAZILIAN PHYSICIANS WORKING WITH IONIZING RADIATIONS. Freire-Maia, Newton; Freire-Maia, Ademar; Quelce-Salgado, A. (Universidade do Parana, Curitiba, Brazil). pp 133-6 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

No clear evidence of genetic damage, as measured by the incidence of abortions, stillbirths, neonatal and infant-juvenile deaths, as well as abnormalities in general, has been verified in the offspring of Brazilian physicians professionally exposed to ionizing radiation. The great majority of the significant differences which have been found as expected, according to the radiogenetics theory, may have been produced by the effect of other factors. Our data do not permit us to conclude that no damage has occurred. As a matter of fact, on the basis of the knowledge gathered in the entire field of radiogenetics, including some data obtained in man, there is no doubt that genic mutations as well as chromosomic aberrations must have resulted from exposure to ionizing radiation. Furthermore some of our findings, for instance, the larger effect of parity on the frequency of abortions in the irradiated samples, could well be explained by induced mutations. However, additional data are necessary in this field of endeavor. (auth)

36094 X-RAY INDUCED ALTERATIONS IN THE MERISTEMATIC CELL CHROMOSOMES OF THE VICIA FABA ROOT TIP. II. INFLUENCE OF TEMPERATURE IN THE FREQUENCY OF CHROMATID ABERRATIONS. Villalobos-Pietrini, R.; Cruz, Teresa; Almanza, R. (Comision Nacional de Energia Nuclear, Mexico City and Universidad Nacional Autonoma de Mexico, Mexico City). pp 137-43 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

The authors studied the effects produced by different temperatures (1, 10, 20, and 30°C) in chromosomes of Vicia faba root tips exposed to 150 R x radiation. There was an increase of chromatid and isochromatid breaks by the effect of high temperatures (20 to 30°C) as well as a greater frequency of isochromatid intrachanges and chromatid interchanges at low temperatures (1 to 10°C). In most cases critical temperatures were found where the frequency of aberrations greatly increased. The latency of broken ends phenomenon and the difference produced by the temperatures mentioned in the restitution and reunion mechanisms were analyzed. The short-termed temperature treatment (1 hour postirradiation) did not alter the mitotic delay induced by radiation of G_2 cells. In this study the authors obtained further evidence of the importance of temperatures in plant radiosensitivity. (auth)

36095 OXYGEN EFFECT DURING X-IRRADIATION ON THE GROWTH OF THE EHRLICH ASCITES TUMOR. ACTION OF DIFFERENT OXYGEN TENSIONS DELIVERED DURING IRRADIATION WITH LOW-DOSE RATES. de Lozzio, Carmen Bertucci; Valencia, Juan I. (Universidad de Buenos Aires). pp 145-53 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

The relation between the cytogenetical damage and the lethal effect induced on a population of ascites tumor cells irradiated in vitro at low-dose rates, with different doses and oxygen tensions, was studied, after inoculation to C3H/Ep mice. Lethal damage to the cell population was induced by irradiation during 1 h with either 4000 R in nitrogen or 2000 R in oxygen at 30 to 60 mm Hg over the normal atmospheric tension. Both treatments produced 100% abnormal metaphases, but 48 hr after 4000 R in nitrogen, 21% of the cells in interphase were giants with great hypochromatic nuclei and big nucleoli, while after 2000 R in oxygen (30 to 60 mm Hg) only 8% of these giant cells were seen. These giant cells are considered to be a type of lethally damaged cell due to alteration of some metabolic pathway necessary for cell division. The growth curves obtained after irradiation with 2000 R at different oxygen tensions showed that the same dose of x rays may be lethal or not depending upon the oxygen tension present during irradiation. Recovery of tumor growth seems to be related to the percentage of undamaged cells remaining after irradiation. Only when 100% of the cells are lethally damaged is the cell population killed. When some undamaged cells remain, they can restore tumor growth. Small proportions of apparently normal metaphases were seen after treatment with 2000 R in nitrogen, air, or low oxygen tensions while after the same dose given at higher oxygen tensions (30 to 60 mm Hg) all the metaphases showed chromosome aberrations. This effect is not due to a real increase of the chromosomal damage, since the mean number of breaks per cell did not vary with the different oxygen tensions used. It seems that it is the result of some kind of sensitization of the most resistant cells of an asynchronous cell population or of an accumulation of cells in a more sensitive period of the mitotic cycle. (auth)

36096 LATERAL DIFFERENTIATION OF THE CHROMOSOME. Swanson, Carl P. (Johns Hopkins Univ., Baltimore). pp 157-62 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

The demands of genetic expression, DNA replication, and chromosomal segregation during somatic cell division require that the mitotic chromosome, prior to the synthetic period of interphase, shall be laterally differentiated so as to possess a minimum of one double helix of DNA of the Watson-Crick type. Furthermore, the principle of parsimony, the general economy of nature resulting from a long evolution, and the exactness of chromosomal replication and segregation would suggest that the minimum and maximum number of lateral strands be the same. The results obtained from autoradiography, enzyme digestion, electron microscopy, and x-radiation are, however, at variance with each other. The use of x-rays has revealed what appear to be subchromatid aberrations at metaphase; this would suggest that the interphase chromosome is at least bipartite laterally, and that it possesses a redundancy of genetic material. The results from autoradiographic and enzymatic studies are equivocal and can be interpreted on either a single- or a multistranded basis. The electron microscope observations have been interpreted in terms of a multistranded structure. X ray evidence obtained from both mitotic and meiotic chromosomes will be discussed and considered in relation to the findings obtained from other modes of attack on chromosome differentiation. (auth)

36097 EFFECTS PRODUCED BY 27.6 Mev DEUTERONS ON THE HEADS OF NEWBORN RATS. Mayo, Jose; Feola, Jose Maria; Cabrini, Romulo L. (Comision Nacional de Energia Atomica, Buenos Aires). pp 181-6 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

The effect of local irradiation to a section of the head of newborn rats (age 0 to 24 hours) was studied using an external beam of 27.6 Mev deuterons. The area studied comprised a 4 × 4 mm quadrangular field, obtained by collimation of the beam with a penetration of 5 mm. In the irradiated sections of the rats changes in calcified tissues (bone and dental tissue), skin, and mucous membranes were primarily studied. The entrance dose varied from 7 to 500

krads. The total dose was estimated in relation to the volume of irradiated tissue. These values ranged from 12 krads to 1 Megarad. Doses of 12 to 20 krads produced destructive lesions in bone and dental tissue and marked acanthosis of the skin. Doses of 55 krads produced areas of necrosis that reached a saturation level at 250 krads. The lesions showed well-defined lines of demarcation between irradiated and healthy tissue. (auth)

36098 RESEARCH ON RADIOISOTOPES AND RADIATION IN INSECT CONTROL RELATED TO THE DEVELOPMENT OF THE STERILE-MALE TECHNIQUE. Weidhaas, Donald E. (Dept. of Agriculture, Washington, D. C.). pp 189-95 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

The use of the sterility principle for the control or eradication of insect pests or vectors of disease offers a new technique in pest control operations. One means of using this new technique is the mass production and release of insects sterilized by gamma radiation into natural populations. The effectiveness of the method has been demonstrated in the successful eradication of the screwworm fly, Cochliomyia hominivorax, from the island of Curacao and the Southeastern United States. A current program in the Southwestern United States has demonstrated that a high degree of control of this same fly in a nonisolated area can be achieved by the method. A recent pilot experiment has also demonstrated that the sustained release of sterilized melon flies resulted in the eradication of this pest of vegetables from the island of Rota in the Pacific Ocean. Over the past several years encouraging results have been obtained in preliminary research on the sterile-insect method for controlling several other important insect pests. Results are summarized from research to date and ways are considered whereby the sterile-insect method might be used alone or integrated with other methods to achieve control or eradication of certain insects. The role of radioisotopes in fundamental studies relating to the development of sterile-male techniques is summarized. (auth)

36099 FURTHER STUDIES ON THE POSSIBLE USE OF STERILE-MALE RELEASE TECHNIQUE IN CONTROLLING OR ERADICATING THE MEDITERRANEAN FRUIT FLY, CERATITIS CAPITATA WIED. FROM CENTRAL AMERICA. Katiyar, Kamta P.; Valerio, Julio (Inter-American Inst. of Agricultural Sciences of the OAS, Turrialba, Costa Rica). pp 197-202 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

Since its recent appearance (1955) in Costa Rica, the Medfly has produced a highly adverse effect on the local fruit industries. In spite of strict quarantine regulations observed on the country's two frontiers, the fly has managed to cross the borders. It has already spread into Nicaragua and is reported recently to have entered Panama. The Medfly meets all the basic requirements for control by the sterile male technique. A cooperative project between the Inter-American Institute of Agricultural Sciences and the Organismo Internacional Regional de Sanidad Agropecuaria (OIRSA) has been under way for the past two years to explore the feasibility of this method of control under Central American conditions. Irradiation tests carried out with a cobalt-60 pool irradiator have shown that males irradiated with 10,000 or 12,500 Roentgens at a 7-, 8- or 9-day-old pupal stage produce sperms with almost 100 percent dominant lethal factors. Females treated at similar stages do not lay eggs beyond 7,500 R. Such pupal treatment inhibits neither the adult's emergence nor decreases its subsequent survival rate. Contrariwise, a slight increase in the longevity of the adults, especially females, was noticed when flies were treated with 10,000 or 12,500 R at the 7-day-old pupal stage. Irradiated males do not seem to compete equally with normal males in insemination. In a laboratory test in small cages, overflooding of the normal population by 39 times with sterile flies reduced the fertility of normal females by 89 percent. To test the laboratory findings in the field, weekly releases of more than half a million irradiated flies have been under way since May 1963 in a small semi-isolated test area of about four square kilometers. (auth)

Radiation Effects Therapy and Countermeasures

36100 (NP-15170) TISSUE THERAPY AFTER IRRADIATION. Koller, P. C. (Chester Beatty Research Inst., London (England)). [1965]. Contract IAEA 103/3/US. 13p. Dep. mn.

Hematopoietic tissue therapy of radiation injury in man has not been widely used because of technical problems involved in obtaining and storing a sufficient number of cells, lack of knowledge of the way in which the response of the host to foreign antigens is modified by irradiation, and the discovery that proliferating foreign hematopoietic cells are able to react against and injure the host. Results are summarized from a detailed study in mice of the optimum conditions for hematopoietic recovery from radiation injury after the administration of various kinds of hematopoietic tissue therapy under controlled conditions, the immune response in irradiated animals, and the response of irradiated animals to injections of foreign bone marrow. Data are included on the part played by the host in hematopoietic recovery from doses of 300, 500, and 700 R x radiation; the pattern of recovery when different numbers of cells were injected; the hematopoietic efficiency of adult bone marrow, adult spleen, or fetal liver cells; the influence of the thymus on the immune response in irradiated animals; the effects of irradiation on secondary responses; promotion of the immune response; and the effects of thymus grafts of the bone marrow donor strain on the survival of irradiated allogenic chimeras. A list is included of 18 publications that report detailed results of these studies. (C.H.)

36101 (JPRS-29788, pp 31-41) GAS EXCHANGE DURING RADIATION SICKNESS. Kurshakov, N. A. Translated from Klinich. Med., 43: 23-7(Jan. 1965).

Changes of the gas composition of the blood during acute and chronic radiation sickness depends on the seriousness of exposure. These changes have a phase characteristic and are determined by the course of the reactions. Development of anemia during the acute and chronic course of the disease leads to a decrease of the oxygen reserves of the blood and due to this, to anemic hypoxia in the period of expressed acute clinical manifestations. The lowering of the oxygen reserves of the blood is caused not only by the decrease of the quantity of hemoglobin in the blood, but also by the lowering of the ability of the hemoglobin to combine with oxygen. For patients with acute and chronic forms of the disease there occurs a dynamic disturbance of the respiratory properties of the blood, expressed by an increase as well as lowering of the affinity of hemoglobin for oxygen with the lowering of the partial tension of oxygen in the blood which can be one of the early causes of developed hypoxia. Hemodynamic disturbances render an influence of the oscillations of the arterial-venous separation of oxygen and the percent of the utilization of oxygen in the tissues. Arterial hypoxia, appearing in half of the subjects with the acute form of radiation sickness, indicates the development of hypoxia on top of the other clinical manifestations. Lowering of oxygen saturation of the arterial blood during light intensity muscular load was noted during chronic forms of radiation sickness and testifies to the disturbance in the correlation between air exchange and blood circulation. In acute cases, basic metabolism in the period of manifested clinical damage is increased, and in the period of restoration, returns to normal. The presence of arterial hypoxemia and delayed dissociation of the oxyhemoglobin in the blood leads to the consideration that during chronic cases of radiation sickness, the period of expressed clinical manifestations of acute sickness in the complex of medical measures, it is

necessary to use the inhalation of oxygen and a combination of oxygen and carbon dioxide. (auth)

36102 ON A METHOD FOR EVALUATION OF RADIATION INJURY PROTECTION BY L-CYSTEINE. Timar, M.; Repciuc, E.; Draghici, C. (Chemical-Pharmaceutical Research Inst., Bucharest). Acta Biol. Med. Ger., 13: 629-32 (1964). (In German)

The effect of L-cysteine to reduce the duration of unconsciousness induced by hexobarbital in x-irradiated mice was studied. The dose levels of irradiation were 100 and 300 R. The duration of unconsciousness was prolonged in proportion to the amount of irradiation administered. No protective effect of cysteine was detectable. When hexobarbital was given after irradiation, leukopenia resulted, even with 100-R irradiation. When cysteine was given along with hexobarbital, a 30% decrease in white cells appeared 48 hr after irradiation with 100 R. The decrease amounted to 50% when 300 R was administered. This persisted for more than 96 hr after administration of the drugs. These effects were attributed to an injury of the reticuloendothelial system by cysteine, which may decrease the protective actions of the reticuloendothelial system against irradiation. In future tests only radioprotective agents that do not injure the reticuloendothelial system should be tested. (BBB)

36103 PREVENTION OF RENAL DAMAGE BY X RAYS. Ascher, A. W. (London Hospital). Brit. J. Radiol., 38: 533-5(July 1965).

The administration of cysteamine 15 min. before 1,200 R x radiation to the kidneys of rats prevented the development of renal damage and hypertension during the first 6 mo. after irradiation. No evidence of radiation sickness or depilation of irradiated skin was observed in the treated animals and they also showed less weight loss than irradiated controls. It was concluded that the kidneys are not selectively protected by cysteamine. (C.H.)

36104 RADIOPROTECTION AND RADIOSENSITIZATION EXPERIMENTS ON CHICKEN EMBRYO ORGANS. Kirrmann, J.-M. (College de France, Nogent-sur-Marne). Bull. Biol. France Belg., 96: 365-463(1962). (In French)

Several reputedly radioprotective chemicals were injected in chicken embryos in such a quantity that mortality did not exceed 50%. The embryos were exposed to 3000, 4000, or 5000 R at 48 hr to induce cyclocephalia and anophthalmia. Cysteamine was very effective, with only six % of the embryos developing malformations. Methylene blue was ineffective. The percentage of cyclocephalias induced was 40, 67, and 67% after 3000, 4000, and 5000 R. After injection with sodium diethyldithiocarbamate, 51% of the embryos developed cyclocephalias. 8-oxyquinoline was radioprotective only for doses of 4000 R or more. There were only 40% cyclocephalias, as opposed to 90% in the controls. All the compounds were radioprotective only if injected before irradiation or in the head. They apparently act on the cellular level to prevent radiolesions. Potassium cyanide, ascorbic acid, and sodium hyposulfite did not have any positive effect. Atmospheres of H, N, and CO_2 showed cyclocephalia development in 7, 21, and 29%, respectively. When eggs were placed, before irradiation, in an atmosphere lacking O_2, they showed a high resistance to irradiation. Eggs placed in pure O_2 before and during irradiation with 3500 R developed 86% cyclocephalia, as opposed to 52% in normal air. The same type of experiment was made on chicken embryos cultivated in vitro. Cysteamine, methylene blue, H, and N had a radioprotective effect on the intestine. (TCO)

36105 EFFECTS OF PRE- AND POST-TREATMENTS WITH S-2-AMINOETHYLISOTHIOURONIUM BROMIDE HYDROBROMIDE ON THE FREQUENCY OF CHROMOSOME ABERRATIONS AND CHLOROPHYLL MUTATIONS INDUCED BY X-RAYS IN BARLEY. Chopra, V. L.; Kapoor, M. L.; Swaminathan, M. S. (Indian Agricultural Research Inst., New Delhi). Indian J. Exptl. Biol., 3: 123-5(Apr. 1965).

The modifications induced by treatment with S-2-aminoethylisothiouronium bromide hydrobromide (AET) on x ray induced chromosome aberrations, growth reduction, and chlorophyll mutations have been studied in barley, (Hordeum valgare L.). In seeds pretreated with AET and then irradiated, both the frequency of chromosome aberrations and chlorophyll mutations register a significant drop; seedling height is not affected. Treatment of seeds with AET in vacuo immediately after irradiation causes a slight but not significant decrease in the frequency of chromosome aberrations. This is perhaps the first record of post-irradiation treatment with AET providing protection against radiation damage. The mechanism of action of AET is discussed. (auth)

36106 RADIATION PROTECTION BY A NUMBER OF SUBSTANCES PREVENTING FREEZING DAMAGE. I. PROTECTION OF MAMMALIAN CELLS IN VITRO. Vos, O.; Kaalen, M. C. A. C.; Budke, L. Intern. J. Radiation Biol., 9: 133-42(1965).

A number of substances preventing cells from freezing damage were investigated with regard to their protective action against x irradiation. Reproductive integrity was used as a criterion for cell-survival. Three groups of compounds could be distinguished. These included substances correlating a protective action against damage due to freezing with a protective activity against radiation injury, such as glycols, glycerol, dimethyl sulphoxide, and other compounds belonging to this group; substances protecting against freezing but not against irradiation, such as pyridine N-oxide being the most typical representative of this group; and substances protecting against irradiation but not against freezing, such as methanol, ethanol, and resorcinol. The results are critically discussed and interpreted as being supportive of Webb's hypothesis that glycerol protects by replacing bound water in the sheath of intracellular macromolecules. Chemicals protecting against freezing injury have polar properties and are able to replace bound water. The fact whether they protect against irradiation or not depends on their other physicochemical properties. (auth)

36107 RADIATION PROTECTION BY A NUMBER OF SUBSTANCES PREVENTING FREEZING DAMAGE. II. PROTECTION OF MICE. Vos, O. (Medical Biological Lab., Rijswijk, Netherlands). Intern. J. Radiation Biol., 9: 179-84(1965).

Intraperitoneal injections of 1 ml 20 per cent propylene glycol, 1.5 ml 10 per cent ethanol, and 0.8 ml 30 per cent glucose reduced 30-day mortality in mice subjected to whole-body x irradiation. Dose-reduction factors of about 1.25 were obtained with propylene glycol and ethanol respectively. The protection lasted for about 1 to 2 hours. Some estimations of the oxygen-tension in the spleen were made. The data suggest that protection against irradiation may be caused by a mode of action other than through anoxia. (auth)

36108 RELATION BETWEEN THE RADIOPROTECTION AND HYPOTHERMIA INDUCED BY CERTAIN CHEMICAL SUBSTANCES. Bacq, Z. M.; Beaumariage, M. L.; Liebecq-Hutter, S. (Universite, Liege). Intern. J. Radiation Biol., 9: 175-8(1965). (In French).

The correlation between the radioprotective effects of cysteamine, cystamine, cysteine, 5-hydroxytryptamine, cyanide, and diethyldithiocarbamate and hypothermia induced by intraperitoneal injection of the chemicals was studied in x irradiated mice. Fluoroacetate, chlorpromazine, and resperine were found to exert a weak radioprotective effect under hypothermic conditions. (C.H.)

36109 RADIATION SICKNESS AND THE INTEGRAL DOSE. (ANTIEMETIC ACTION OF TORECAN). Oliveira, Idalio (Hospitals Civis de Lisboa, Portugal). J. Med. (Oporto), 54: 517-24(June 27, 1964). (In Portuguese)

Factors which predispose patients to radiation sickness during radiotherapy are discussed, and a clinical trial was made of a piperazine derivative of a phenothiazine drug in preventing this condition. Development of radiation sickness is dependent upon the radiation dose administered and

the volume irradiated. The concept of the integral dose or the dose-volume is explained in this connection. Occurrence of radiation disease is directly proportional to the integral dose. The region irradiated is also a factor, the upper abdomen and the parotid gland being the most sensitive regions in terms of stimulating radiation sickness. The mucosa of the duodenum and jejunum, the solar plexus and celiac ganglion, or the adrenals have been cited as the source of greatest sensitivity of the upper abdomen. Some previously used preventive drugs for radiation sickness are reviewed, including reports of success with vitamins (especially pyridoxine), cysteamine, and Tigran. A clinical trial was made with Torecan or 3-ethylthio-10(1′-methylpiperazinyl-4-propyl)-phenothiazine, which has been used previously as an anti-emetic. Thus, it is effective in preventing vomiting in animals treated with the emetics $CuSO_4$ and apomorphine. The physiology of vomiting and the chemoreceptor trigger zone in the central nervous system are discussed in terms of radiation sickness. Detailed information, including radiation technique and doses, is given for each of 80 patients administered Torecan during radiotherapy. The results are interpreted as indicating that Torecan prevented radiation sickness in 70%, showed some benefit in another 18.75%, and failed to prevent it in 11.25% of cases. Thus, its positive effect was noted in 88.75% of cases. In three cases (3.25%) the drug had to be stopped because of side-effects. The drug was administered as tablets, suppositories, or ampoules of 6.5 mg; usually three doses per day were given. (BBB)

36110 PROTECTIVE EFFECT OF PHENETHYL ALCOHOL AGAINST ULTRAVIOLET IRRADIATION OF ESCHERICHIA COLI. Lipschutz, Rivka; Avigad, G.; Falk, R. (Hebrew Univ., Jerusalem). Life Sci., 4: 665-70(Mar. 1965).

β-phenethyl alcohol (PEA) inhibits cell division of gram-negative bacteria and acts as a specific inhibitor of DNA synthesis. In a study of the effects of various metabolic states on the mutation rate of several loci in Escherichia coli strains it was noted that the presence of PEA in the medium strikingly protected cells against the lethal effect of uv irradiation. Ultraviolet irradiation with a measured intensity of 4.27 erg/sec/mm^2 at 2537 Å and at a distance of 13 cm was used. To test the PEA effect, it was added to the cell suspension two hr before irradiation and incubated at 37°C in the rotary shaker. The high dilution of PEA in the samples after irradiation was sufficient to eliminate its inhibitory effect on bacterial growth. At a concentration of 0.34%, PEA after two hr of incubation stopped net DNA synthesis but had only a small inhibitory effect on the rate of RNA and protein synthesis in the cells. At this stage of PEA treatment, cells were found to be much more resistant to the lethal effect of uv irradiation. Similar results were obtained whether cells were suspended in a medium with or without the addition of orthophosphate (to regulate the formation of alkaline phosphatase). Similar results were found with steady-state cells washed and irradiated in a PEA-salt solution (without peptone and sugar). When cells were preincubated with PEA for different time intervals, a gradual increase in resistance to uv killing could be observed. However, a considerable protective effect was found already after three minutes of preincubation. Enhanced protective effect also resulted by increasing PEA concentrations. Cells which were incubated for two hr in 0.34% PEA and irradiated with 770 erg/mm^2 had a survival of 6×10^{-2}. A partial PEA protective effect remained even in washed cells. PEA has an absorbance in the uv region with a sharp peak at 257 mμ and a relatively low molar extinction coefficient; hence, at least part of the protective effect exerted by PEA is probably associated with this absorption characteristic which fairly corresponds to the bactericidal effect of the uv wavelength used. The possibility that the protective effect of PEA is associated with inhibition of thymine dimer formation in DNA of irradiated bacteria, or with the dimer excision repair mechanism of DNA is also considered. (BBB)

36111 TWO-STAGE TRANSPLANTATION OF ALLOGENIC BONE MARROW IN SEVERE EXPERIMENTAL RADIATION SICKNESS. Chertkov, I. L.; Rogacheva, L. S.; Shepshelevich, L. L.; Raushenbakh, M. O. (Central Order of Lenin Inst. of Hematology and Blood Transfusion, Moscow). Med. Radiol., 10: No. 6, 34-42(June 1965). (In Russian).

The effects of two-stage transplantation of bone marrow in dogs with radiation sickness were studied. The first was applied after whole-body irradiation (100 R) and the second 5–6 days after the first, on the assumption that the first transplantation would help the animals survive until the second took effect. The first was not therapeutic and the hemopoietic cells did not change into immune lymphocytes. The second transplantation took and the recipient animals' hemopoiesis was partly compensated. Two of 14 experimental dogs survived. The donor animals' cells were sloughed off 4–5 weeks after irradiation and the therapeutic effect persisted because at this time the restoration of hemopoiesis enabled the recipient animals to survive. Sloughing off of the transplant earlier (16 days after irradiation) prevented restoration of hemopoiesis, resulting in the animals' death. Thus, in itself the transformation of hemopoietic cells into immunoblasts and immunocytes was not fatal to the animals. The immunological reaction was apparently brief because the resultant immunologically incompetent cells multiplied only during the first two days. The death of the dogs that received only one transplantation of bone marrow was due mainly to noncompensated hemopoiesis. The results indicate that two-fold transplantation of bone marrow is somewhat effective after massive irradiation. (ATD)

36112 ON THE CONVERSION OF POTENTIAL RADIOPROTECTORS INTO ACTIVE PROTECTIVE SUBSTANCES IN THE ANIMAL ORGANISM. Yakovlev, V. G. Med. Radiol., 10: No. 6, 47-61(June 1965). (In Russian)

The literature is reviewed on efforts to find chemical substances that change in the body into sources of protection against radiation without producing side effects or toxicity. Attention is focused on sulfur-containing compounds. Intramolecular transdeamination of isothiouronium compounds, transformation of disulfides, splitting of thioesters, hydrolysis, oxidation, and reaction of complex thioesters are discussed. Trends of research emerging from the data on sulfur-containing potential radioprotectors are: modification of the chemical structure of substances so that they may be transformed in a given direction; chemical synthesis or isolation from natural materials of substances for which methods of biochemical transformation are known; and minor structural changes in natural compounds by introducing new or altering existing functional chemical groups. Of the various groups of compounds reviewed, the most promising seem to be the complex thioesters, specifically, certain aminoalkylthio-compounds containing groupings of thiosulfenic and thiosulfinic acids. (CFSTI)

36113 MODIFICATION OF RADIATION-INDUCED INJURY IN BARLEY BY PRE-TREATMENTS WITH SOLUTIONS OF DIFFERENT OXMOTIC POTENTIAL. Gillet, Claude (Universite, Liege). Nature, 206: 99-100(July 3, 1965).

Radiation protection provided barley seeds by soaking in calcium chloride was studied. The physiological effects relating to the osmotic potential of the soaking solutions were proposed to explain the results. The barley seeds were soaked for 12 hr at room temperature in 0.05, 0.25, 0.5, 1, 1.5, 3, and 4M solutions of calcium chloride and then irradiated to 0.25 to 12 krad. There was a linear relationship between the osmotic potential of the calcium chloride solutions and the moisture content of the barley seeds. There was no difference in radiation resistance between the seedlings issued from seeds pretreated in 0.05M calcium chloride solutions or from those soaked in distilled water. But with increasing molar concentration, the damage by x rays for a given dose was reduced. The maximum protective effect was afforded with 1.5M

solution. The concentrations above this value were not more efficient. The results suggested that the protective effects of different salt solutions are related to their osmotic properties. (M.C.G.)

36114 RADIOPROTECTIVE ACTION OF CALCIUM ON SERRATIA MARCESCENS. Jayson, G. G.; Pickering, D. C.; Markham, W.; Parker, M. S. (Coll. of Tech., Liverpool). Naturwissenschaften, 52: 185(1965).

The radioprotective action of Ca was investigated on the soil bacterium Serratia marcescens. Suspensions of the washed cells, to which calcium had been added, were exposed to x radiation at a dose of 534 rads/min. The results showed that the presence of calcium ions in the suspension protected the organism. The dose reduction factor for 37% survival was 2.1. (J.S.R.)

36115 CURRENT KNOWLEDGE OF RADIOACTIVE RADIATION PROTECTION. Dolder, R. (Kantonsapotheke, Zurich). Pharm. Acta Helv., 40: 193-204(Apr. 1965). (In German)

A brief summary of radiotoxicity of radioisotopes is prefaced by a short exposition of the biochemical effects of irradiation and principles of protection against irradiation. These include the use of distance, shielding, reduction of exposure time, and use of radioprotective agents. Toxicity of some radioisotopes is compared with the chemical toxicity of the same, but nonradioactive element. The incorporation of radioactive particles by inhalation or ingestion is described. The normal mode of removal of deposited radioisotopes is described and compared to removal by several treatments used to accelerate radioisotope excretion. Specifically, the radioisotopes mentioned include heavy metals, such as Pu, Ra, and Co, and lighter elements such as Sr and Cs. A specific procedure for prophylaxis against incorporation of ^{131}I that is mentioned consists of feeding of KI. Daily treatment with 0.2 g might prevent incorporation of ^{131}I by the thyroid gland for a period of 1 or 2 days. The treatment should be continued for at least two or three times the half life of the ^{131}I after exposure to the radioisotope has ceased. (BBB)

36116 RADIATION INFLUENCE ON VEGETATIVE FUNCTIONS OF ORGANISM BY INJECTION OF RADIOPROTECTORS. Minaev, P. F.; Mironova, A. P. (Inst. of Biological Physics, Moscow). Radiobiologiya, 5: 362-6 (1965). (In Russian)

X irradiation of the cerebellar region of dogs to 15 kR did not obviously affect breathing or blood pressure immediately. After 30 min the nature of the breathing and the amplitude of the heart contraction changed but lowering of the blood pressure occurred much later. Radiation-protection substances (Nembutal, Hexone, Alinamin) administered before irradiation prevented the changes at the time of irradiation. (tr-auth)

36117 ON THE PREPARATIONS REDUCING THALLIUM-204 ABSORPTION IN GASTROINTESTINAL TRACT. Bokk, M. I.; Il'in, L. A. (Scientific-Research Inst. of Radiation Protection, Leningrad). Radiobiologiya, 5: 434-9 (1965). (In Russian)

Cation and anion exchange resins, pectic substances, barium sulfate, and adipic acid had no effect on absorption of ^{204}Tl in the GI tract, and activated carbon had only a slight effect. The effectiveness of zirconium phosphate was demonstrated, and the use of this compound when ^{204}Tl entered the organism decreased the dose 2-fold to the liver, muscle, and kidney and 1.5-fold to the GI tract. (tr-auth)

36118 INFLUENCE OF IONIZING RADIATION AND AND PHYSIOLOGICALLY ACTIVE COMPOUNDS ON METABOLISM IN PLANTS. Il'ina, G. V.; Kuznetsova, N. N.; Rydkii, S. G. (Moscow State Univ.). Radiobiologiya, 5: 446-50(1965). (In Russian)

Irradiation of water-swollen sugar beet seeds to 2 kR decreased the soluble carbohydrate content in the above-ground part of the plant and the sugar content of the root. Wetting the seeds with cysteine or P-46 solutions decreased the effect of irradiation and increased the root sugar. (tr-auth)

36119 CYTOCHEMICAL AND CYTOSPECTROPHOTOMETRIC STUDY OF LEUCOCYTES OF RATS SUBMITTED TO INTERNAL IRRADIATION WITH ^{32}P. UTILIZATION OF ASCORBIC ACID AS A RADIOPROTECTOR. Turcu, Grigore; Vasilescu, Vasile; Dimoftache, Constantin; Wexler, P. (Inst. of Medicine and Pharmacy, Bucharest). Rev. Roumaine Biochim., 1: 343-53(1964). (In French)

Twenty-six- to eight-month-old male rats of the Wistar strain were divided into four groups: A, B, C, and D. Groups A and C were injected with one $\mu C/g$ $Na_2H^{32}PO_4$; groups B and D with two $\mu C/g$. Groups C and D also received 100 mg/day vitamin C in their diet. In group A there was no significant decrease in leukocytes until the sixth day. From the sixth to the 12th day, the leukocytes declined to about 55% of their normal level. By the 20th day, the leukocyte count returned to 83% normal. In group B, the count fell to 30% between the third and 12th day. By the 20th day it was only 51% normal. Group C dropped to 45% normal by the sixth day and returned to 79% by the 20th. Group D dropped to 50% the first day and returned to 64% by the 20th day. The lymphocyte count dropped in all groups the first day. In groups A and B the decrease was related to the dose received, unlike the protected groups C and D. By the 15th day, the counts had reached: group A: 68%; B: 54%; C: 66%; and D: 57% of normal. The neutrophil count increased sharply, decreased and then increased again in A and C to 89 and 91%, respectively. The count decreased, increased, then declined slightly in B and D to 51 and 76%. After irradiation, the percentage of granulocytes highest in phosphatasic activity increased in all groups. The increase was greatest in groups C and D, which received ascorbic acid. Cytospectrophotometric curves of lymphocytes in all four groups showed that the nuclear material in all cases was not normal. The modifications of nuclear material caused by irradiation were not influenced by ascorbic acid. (BBB)

36120 THE MORTALITY OF LETHALLY IRRADIATED MICE GIVEN MARROW OF VARYING DEGREES OF HISTOCOMPATIBILITY. Morgado, Fernando; Pizarro, Olga; Ramos, Alicia (Universidad de Chile, Santiago). Transplantation, 3: 517-23(July 1965).

The treatment of lethally irradiated mice with adult allogenic marrow of known histocompatibility difference was studied. The lowest therapeutic effect was obtained with difference between host and donor at the strong H-2 locus. Less mortality was observed with difference at the weaker H-1 or H-3 locus. Where host and donor differed simultaneously at H-2 and H-1 or H-2 and H-3, the final result was similar to that obtained with difference at H-2 alone, but the onset of mortality was delayed. The H-1 and H-3 loci together did not add their individual effects on mortality. Early mortality was observed with marrow of F_1 hybrids. The possibility of residual host-versus-graft reaction due to the low dose rate of radiation is described. (auth)

36121 ANTIBIOTIC CONTROL OF POST-IRRADIATION DEATHS IN MICE DUE TO PSEUDOMONAS AERUGINOSA. Wolf, Norman; Stenback, Wayne; Taylor, Patricia; Graber, Charles; Trentin, John (Baylor Univ., Houston, Tex.). Transplantation, 3: 585-90(July 1965).

The appearance of Pseudomonas aeruginosa in the gastrointestinal flora of a colony of mice used for irradiation and bone marrow transplantation studies resulted in premature deaths (3 to 8 days post-irradiation) with Pseudomonas septicemia. Of many antibiotics tested in vitro and in vivo, only two, gentamicin (Garamycin sulfate, Schering) and streptomycin proved effective in vivo. Parenterally administered gentamicin (2 to 4 mg/mouse) given alone or in combination with streptomycin (5 to 6 mg/mouse) made irradiation experiments possible in Pseudomonas-infected mice without excessive early mortality with Pseudomonas septicemia. Effectiveness of therapy was related to dose of antibiotic, increasing dose of bone marrow, strain of mice, and other factors. (auth)

36122 MODIFICATION OF THE GENETIC EFFECT OF IONIZING RADIATIONS IN BARLEY. Malvarez, Elsa M.; Favret, Ewald A.; Ryan, Guillermo S. (Istituto de Fitotecnia, Castelar, Argentina). pp 121-32 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

Modification, as a result of treatment during, prior, or after irradiation, of certain effects caused by ionizing radiation lead one to believe in the possibility of controlling at will the mutational process. Our contribution includes experiments using ionizing radiations (x and γ) in an effort to modify their action by cysteamine, ethyl methane sulfonate, and oxygen treatments. Pretreatment with cysteamine reduces the initial damage produced by ionizing radiations and also the frequency of induced chromosomic damage but it does not modify or even slightly increase the frequency of chlorophyllic mutations. Pretreatment with ethyl methane sulfonate protects against initial damage and reduces mutational frequency; on the other hand, posttreatment shows an additive effect of both. Experiences with oxygen confirm its mutagenicity only when applied at pressures above normal levels and for comparatively long periods, (10 to 45 days); combined with radiation the effects accumulate, resulting in a marked storage effect in irradiated seeds. (auth)

36123 AMINO ACIDS IN THE RECUPERATION OF ESCHERICHIA COLI IRRADIATED WITH X-RAYS AND ULTRAVIOLET LIGHT. Lumi, Rita; Orce, Luis V.; Bobbi, Carlos (Comision Nacional de Energia Atomica, Buenos Aires). pp 173-9 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

Under normal conditions (without irradiation) Escherichia coli bacteria of the B/r strain develop with similar characteristics in synthetic media (mineral salts and glucose as the only source of carbon) or in these same media enriched with peptones. However, after being irradiated with x rays or ultraviolet light these organisms show a marked decline in their capacity to express survival in the synthetic media as compared with the recuperation that takes place in complete media. The availability of peotones of well-defined chemical composition made it possible in this work to determine which of their 18 amino acids are responsible for the higher percentage of recuperation, and in other cases, which show an inhibitory effect. It is established that, for both x rays and ultraviolet light, glutamic acid, methionine, and aspartic acid are key amino acids, and that their effect in recuperation is much more intensive and effective in different doses for ultraviolet light than for x rays. (auth)

Radiation Hazards and Protection

See also HEALTH AND SAFETY.

Refer also to abstract 38014.

36124 (N64-29369) COMPUTER CODES FOR THE EVALUATION OF SPACE RADIATION HAZARDS. VOL. 7. SPACE RADIATION DOSES FROM PRIMARY PROTONS. Moshofsky, Raymond P. (Boeing Co., Seattle, Wash. Aero-Space Div.). [1964]. Contract NAS9-1393. 37p. (NASA-CR-58298; D2-90418-7). CFSTI, $3.60

Radiation environments in space include protons from solar flares and protons in the trapped radiation belt surrounding the earth. In order to evaluate the hazard to space systems arising from these protons, an IBM 7094 FORTRAN program was developed. This program calculates the radiation dose to men or equipment located inside the space vehicle in such an environment. Required input data for these calculations include materials and their thicknesses observed from the dose point inside the vehicle, physical properties of the shield materials involved, and incident proton energy spectrum and angular distribution. Optionally, the program can compute the density of defects produced in semiconductor materials. This requires the additional input of points from a response function that converts proton flux to defect density. (auth)

36125 (RL-SA-15) RADIATION CONTROL OF ACCIDENTALLY CONTAMINATED SEEPAGE PONDS. Backman, G. E.; Roddy, L. W. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). June 3, 1965. Contract AT(45-1)-1350. 18p. (CONF-650616-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Health Physics Society, Annual Meeting, Los Angeles.

In June 1964, a leak developed in the cooling coil of a process waste inventory tank in the Purex Plant, resulting in contamination of two ponds. An account is given of the immediate and long-term radiation control measures taken; they included reduction of high radiation levels, radioactivity determinations in water fowl, elimination of algae and invertebrate life, and soil sterilization. It is concluded that the problem is well under control, as most of the radioactivity is adsorbed on the bottom sediments. (D.L.C.)

36126 DYNAMIC SIMULATION OF THE A4D FLASH BLINDNESS PROTECTIVE SYSTEM. Chisum, Gloria T.; Hill, J. H. Aerospace Med., 36: 533-7(June 1965).

Operation of the A4D thermal protective system consisting of a buggy-top thermal enclosure and ELF goggles was evaluated under acceleration stresses of 1.2 to 5 G. Five experienced pilots and three non-pilot subjects operated the system within empirically predetermined limits of safety. All subjects were within the 5th to 95th percentile size range of navy pilots. Subjects in the lower third of the size range exhibited greater facility in operation of the system than those in the upper two-thirds of the size range. It is concluded that under the conditions described in this paper pilots of A4D aircraft will be able to use the thermal shield-ELF flash blindness protective system and maintain safe operation of the aircraft. (auth)

36127 MEDICAL RADIATION: PERSPECTIVES IN RISKS AND REWARDS. Chamberlain, Richard H. (Univ. of Pennsylvania, Philadelphia). Am. J. Public Health, 55: 720-30(May 1965).

Some ways by which the radiologist can reduce patient exposure in x-ray diagnosis are enumerated, and an attempted assessment is made of the risks of diagnostic radiology as balanced by its benefits. It is concluded that the expenditure of radiation should be made with a highly developed sense of economy and of conscience, as well as skill, so that the risks may be kept to the lowest reasonable levels; also that the rewards of radiation in terms of the greatest possible information on individual patients and their extension to public health problems be sought with a high level of competence and full use of modern techniques. (TCO)

36128 RADIATION AND HEALTH. Brit. Med. J., 2: 1480(Dec. 12, 1964).

Some current problems in evaluating the possible hazards of medical irradiation, especially as regards leukemia and genetic damage, are reviewed briefly. Leukemia, though numerically a relatively slight hazard of radiation, arouses strong emotions, especially in relation to young children, and is one of the most sensitive indicators of population irradiation. It is accepted that diagnostic radiology cannot be neglected as a cause of leukemia and estimates indicate that radiation in utero may be partly responsible for 5% of all childhood leukemia. X-ray examination of pregnant women should be avoided or delayed when possible. Though radiology is the major source of man-made radiation, there is no doubt that the benefits outweigh the risks, provided that technical competence and responsible judgment are applied. The genetic hazard is a long-term problem and an important one, since radiation is a powerful and subtle tool for bringing about changes in hereditary material. The influence of radiation on traits determined by multifactorial inheritance is probably of less urgent concern. Radiation levels of the present day probably do not constitute a major

genetic hazard. Support is found for this in the negative or inconclusive results of attempts to discover a higher incidence of leukemia and other malignant diseases in areas of high natural background radiation. There is no evidence that natural radiation influences the cancer rate in man, and present and expected exposures to radioactive fallout probably will not produce demonstrable effects on the incidence of malignant disease. Although the present safety measures may be more than adequate, there is a need for effective control. Existing standards should not be relaxed, but a fresh appraisal of the underlying criteria should be attempted. (TCO)

36129 PLUTONIUM ABSORPTION—EVALUATION AND TREATMENT. Fuqua, P. A. (Hanford Atomic Products Operation, Richland, Wash.). Ind. Med. Surg., 34: 335-7(Apr. 1965). (HW-SA-3730(Rev.))

The medical handling of workers contaminated with Pu is outlined. The α-emitting Pu, once in the body, deposits in bone and liver and is excreted very slowly. A maximum permissible bone burden for ^{239}Pu of 0.04 μC compared to 0.1 μC for ^{226}Ra was thus established. The chemical toxicity of Pu is much less than its radiotoxicity and control of the latter is more than adequate to prevent chemical injury. The decay energy per disintegration may result in very high local tissue doses which may lead to varying degrees of cell damage, malignant change, or death of the tissue. Absorption via the blood stream results in deposition in the liver and in the organic bone matrix, requiring an estimated 200 yr to eliminate one-half the amount absorbed. Absorption from the lung may be 1 to 10% of the amount of Pu inhaled. Depending on particle size, solubility, and chemical form, as much as 20% of the inhaled Pu may be retained in the lung. In a Pu contamination case, the key points in the medical history are: exactly what happened and when; the physical and chemical state of the Pu, and degree of solubility (solubility in water and in tissue fluids may not be the same); length of time exposed and Pu air concentration if inhalation exposure has occurred; the body part and tissue involved; and history of kidney or liver disease. Surgical excision, when Pu is in skin or subcutaneous tissue is indicated for any amount which is easily accessible. For Pu introduced into the body via wounds, prompt excisions can result in over 90% removal. In cases where surgical removal is less effective, local DTPA (diethylenetriaminepentaacetic acid) washes and intramuscular or intravenous injections of DTPA may be used. In skin contamination cases where Pu is only on intact skin, careful use of soap and water, detergents, $KMnO_4$ and $NaHSO_3$, and salicylic acid most commonly effect removal. In inhalation exposures the best estimation of the lung content of insoluble Pu is by the Pu content of feces during the first four days after the exposure and by the urine content thereafter. Magnesium sulfate may be indicated to hasten excretion of the Pu which is brought up from the lungs and swallowed. DTPA is the most effective agent now available to bind and mobilize Pu for urinary excretion. Daily urine assay gives some index of the body deposition and the results from treatment. (BBB)

36130 QUANTITIES AND UNITS IN NEUTRON RADIATION PROTECTION. Nachtigall, D. (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 7: 253-5(June 1965). (In German)

The conceptions and quantities used in the field of neutron radiation protection are defined and listed in tabular form together with its symbols and units. (P.C.H.)

36131 THE TECHNIQUE FOR CALCULATING THE IRRADIATION DOSE AND MAXIMUM PERMISSIBLE CONCENTRATION OF FRESH FISSION FRAGMENT ACTIVITY FOR DIFFERENT REGIONS OF THE GASTROINTESTINAL TRACT. Malykhin, V. M.; Shamov, V. P. Med. Radiol., 10: No. 5, 82-3(May 1965). (In Russian)

A method is presented for calculating the radiation dose to various parts of the gastrointestinal tract from fission products. An example is included along with formulas for dose loadings. (H.G.D.)

36132 POLONIUM-210 CONTENT OF MAINSTREAM CIGARETTE SMOKE. Kelley, Thomas F. (Bio-Research Consultants, Inc., Cambridge, Mass.). Science, 149: 537-8(July 30, 1965).

When eleven brands of cigarettes were smoked in a standardized manner, differences in the polonium-210 content of various brands were found. The differences were not directly related to the presence of a filter or to the construction of the filter, but were related to the amount of particulate matter in the mainstream smoke. (auth)

36133 RADIOGRAPHY. Carlson, William D. (Colorado State Univ., Fort Collins). p. 151-65 of Methods of Animal Experimentation. Vol. I. William I. Gay. ed. New York, Academic Press, 1965.

The use of x rays for radiographic studies in experimental animals is reviewed, with some recommendations for radiation protection. Radiographic research procedures with animals lend themselves to the inadvertent exposure of the investigator to the hazards of radiography. The nature of the experiment may be so important to the scientist that it often comes first over all other considerations, and it is easy to compromise on the safety procedures. Rules that should be followed regardless of the circumstances are listed and discussed. (TCO)

Radiotherapy and Radiodiagnosis

Refer also to abstracts 35930, 36034, 36040, 36049, 36055, 36058, 36084, and 36880.

36134 THE DEVELOPMENT OF RADIOLOGICAL INSTITUTES IN HUNGARY. Deak, P. Acta Chir. Acad. Sci. Hung., 4: viii-xiii(1963).

The design and construction of radiology departments for diagnosis and treatment are discussed, and some new radioprotective features are mentioned. (BBB)

36135 INTEGRAL ABSORBED DOSES IN ROENTGEN DIAGNOSTICS. A THEORETICAL ANALYSIS AND CLINICAL APPLICATION. Carlsson, Carl (Univ. of Lund, Sweden). Acta Univ. Lund., Sect. II, No. 18, 1-9(1964).

Integral absorbed doses to patients undergoing roentgen diagnostic examinations were measured. For this reason a plane-parallel ionization chamber and a suitable measuring and recording circuit were developed. The ionization chamber measures, in units of R cm^2, the product of exposure in air and beam cross section. From the measurements of the product of exposure and area the integral absorbed dose was calculated from known spectra of the incident radiation, energy absorption coefficients for air, and a determination of incident and escape energy. The records show the distribution of the integral absorbed dose from each moment of the examination. Finally, the results from about 2000 measurements of integral absorbed dose are reported. (auth)

36136 MALIGNANT MELANOMA OF THE CHOROID TREATED WITH PHOTOCOAGULATION, TRANSSCLERAL DIATHERMY AND IMPLANTED RADON SEEDS. Boniuk, Milton; Girard, Louis J. (Baylor Univ., Houston, Tex.). Am. J. Ophthalmol., 59: 212-16(Feb. 1965).

A malignant melanoma of the choroid was unsuccessfully treated with photocoagulation, transscleral diathermy and radon seeds. Pathologic examination revealed little or no effect of treatment on the malignant melanoma. Photocoagulation was presumably responsible for an iatrogenic retinal break, progressive cataractous changes and necrosis of the pupillary and midzonal portions of the iris. Radiation fibrosis and vasculitis were apparently responsible for the postnecrotic scarring involving the anterior portion of the optic nerve. (auth)

36137 DIFFERENTIAL LOCALIZATION OF ISOTOPES IN TUMORS THROUGH THE USE OF INTRAARTERIAL HYDROGEN PEROXIDE. Basic Science. Finney, James W.; Balla, George A.; Collier, Richard E.; Wakley,

Jack; Urschel, Harold C.; Mallams, John T. (Baylor Univ., Dallas). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 784-8(Aug. 1965).

Both ^{131}I-labeled human serum albumin and [3-(chloromercuri)-2-methoxypropyl]-urea-^{203}Hg will localize preferentially in the area of malignant tumor tissue when given intraarterially during the intraarterial infusion of dilute hydrogen peroxide in either tumor bearing animals or human beings. Autoradiographic data indicate the intracellular geographic distribution of the isotope. It is our opinion at this time that much further investigation is necessary, but that there is potential applicability in both diagnosis and treatment of malignant tumors. (auth)

36138 DIFFERENTIAL LOCALIZATION OF ISOTOPES IN TUMORS THROUGH THE USE OF INTRAARTERIAL HYDROGEN PEROXIDE. Clinical Evaluation. Collier, R. E.; Balla, G. A.; Finney, J. W.; D'Errico, A. D.; Tomme, J. W.; Miller, J. E.; Mallams, J. T. (Baylor Univ., Dallas). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 789-97(Aug. 1965).

A new technique of tumor localization with intraarterial injection of hydrogen peroxide and radioiodinated serum albumin has been described. The time of the scan is not critical. The best tumor outline is obtained at 48 and 72 hours. Thirty-seven cases have been scanned as a pilot study. There were 30 positive scans, 3 questionably positive scans, 3 negative scans, and 1 false-positive scan. Various pathologic types of tumors have been demonstrated including sarcomas, adenocarcinomas, and squamous cell carcinomas. There does not seem to be any specificity as regard to cell type and the ability to concentrate the isotope in the tumor with the technique described. The technique is of value in outlining tumor size and extent of involvement so that proper therapy can be planned. It can be used to follow the results of therapy using radiation or chemotherapy. The possibilities of the application of the technique in the treatment of malignant tumors and the study of the cellular metabolism are considered. (auth)

36139 SULFUR 35 STUDIES IN HUMAN CHONDROSARCOMA. Andrews, J. Robert; Holland, Paul (Georgetown Univ., Washington, D. C.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 798-806(Aug. 1965).

Data have been developed on the human hematopoietic and chondrosarcoma dosimetry of large doses of ^{35}S administered intravenously. Sulfur-35 is deposited in relatively high concentration in viable zones of human chondrosarcoma and is retained there for an extended period of time. The dose-limiting factor in the possible therapeutic administration of ^{35}S is the depletion effect on the hematopoietic tissues. The combined administration of ^{35}S and external beam x irradiation has resulted in beneficial clinical responses in some patients with inoperable chondrosarcoma. (auth)

36140 TECHNETIUM 99m NORMAL BRAIN SCANS AND THEIR ANATOMIC FEATURES. Webber, Milo M. (Univ. of California, Los Angeles). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 815-18(Aug. 1965).

The advent of greater apparent detail brain scanning using ^{99m}Tc makes it necessary to explain more of the detail of the pictures obtained. An anatomic consideration of normal brain scans is presented. (auth)

36141 A DIAGNOSTIC PITFALL WITH RADIOIODINE SCANNING. Zalis, Edwin G.; Ellison, Richard B.; Barrett, O'Neill Jr. (Letterman General Hospital, San Francisco). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 837-8(Aug. 1965).

A ^{131}I scintiscan of a woman made during lactation showed concentration of radioactivity that led to an initial false interpretation of metastatic carcinoma of the lungs. Correct interpretation was made after repeating the scan with displacement of the breasts. It was established that the activity was from the breasts which were actively secreting ^{131}I. (auth)

36142 ISOTOPE LOCALIZATION AND SCANNING OF THE PLACENTA. Klein, Edward W.; Hopwood, Herbert G. Jr. (Naval Hospital, Great Lakes, Ill.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 844-7 (Aug. 1965).

Isotope localization (placentogram) of the placenta is reviewed. RISA placentography has proven to be of equal or greater accuracy than roentgen studies. It is safe, expeditious, and inexpensive. Second trimester localization has been reported as accurate. Radiation exposure to mother and fetus from a 5 μC dose of ^{131}I is significantly less than that received from roentgen placentography. A method for this procedure is outlined. Placental scanning in 2 patients is discussed and the case histories are presented. (auth)

36143 AN ANALYSIS OF FACTORS AFFECTING OPTIMAL AXIS PLACEMENT AND 80% ISODOSE VOLUME DIMENSIONS IN TELECOBALT ARC THERAPY. Turner, J. E.; Johnson, R. M.; Whitfield, S. M. (Veterans Administration Research Hospital, Chicago and Northwestern Univ., Chicago). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 852-64(Aug. 1965).

By means of 25 diagrams and 2 tables this study presents the location and magnitude of the maximum dose generated by various telecobalt arc therapy techniques; the anteroposterior, transverse, and longitudinal dimensions of the volume enclosed by the 80%-of-maximum isodose surface (designated the effectively treated volume); and an axis placement guide which indicates where to locate the rotational axis so as to place the tumor's center at the center of the effectively treated volume. The data are presented for 36 nominal axis-field sizes (width or length 4, 6, 8, 10, 12, and 15 cm) and for arc spans of 120, 180, 240, 300, and 360 degrees. The data are not transferable and apply only to telecobalt machines having a source diameter of 2 cm, a source-to-collimator distance of 33 cm, and a rotational radius of 75 cm. Sample equations and problems show how to calculate tumor doses and treatment times when the rotational axis does (for arcs of 360 degrees) and does not (for arcs of less than 360 degrees) coincide with the location of the maximum dose generated. (auth)

36144 A FAST MOVING-FIELD TELECOBALT TISSUE-DOSAGE METHOD FOR ADDING MACHINE, TABULATING MACHINE, OR ELECTRONIC COMPUTER. Turner, J. E.; Johnson, R. M.; Whitfield, S. M. (Northwestern Univ., Chicago). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 865-79(Aug. 1965).

A fast tissue dose system for multifield and rotational telecobalt therapy is presented for source diameter 2 cm, source-collimator-distance 33 cm, and source-center-distance 75 cm. The data cover field widths of 4, 6, 8, 10, 12, and 15 cm, as measured at the axis (60 per cent isodose line). Tissue doses at any of 469 points within the patient may be calculated by adding machine in 40 to 60 seconds per point; by automatic tabulating machine in 4 to 30 minutes for the entire 496-point distribution; or by computer for a library of 146 of the 469-point dosage distribution in 90 minutes. Tumor/air dose ratio and percentage depth dose sheets are presented for the adding machine system. Sample punch card and print-out formats are presented for the tabulating machine and computing systems. Depth dose data presented are normalized to 100% of tumor/air dose ratio at axis of rotation, but other normalizations are possible. The cross-sectional distributions developed from the data are largely independent of patient's size and shape. A basic library of 146 dosage distributions is described. This library can be made available in the form of duplicate punch cards, print-out sheets, and 2 × 2 inch slides. (auth)

36145 A COMPUTER PROGRAM FOR ROTATIONAL TREATMENT PLANNING. Mauderli, Walter; Fitzgerald, L. T. (J. Hillis Miller Health Center, Gainesville, Fla.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 880-7(Aug. 1965).

A method is described for the automatic computation of

a rotation treatment plan and the automatic plotting of isodose curves within the body cross section. The procedure is in routine use for dose calculations for a Van de Graaff unit. (auth)

36146 A SIMPLE, INEXPENSIVE, MANUALLY-OPERATED ISODOSE PLOTTER. Robinson, J. Eugene; McDougall, R. S. (Univ. of Maryland, Baltimore). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 888-93 (Aug. 1965).

The construction and operation of a simple, manually-operated isodose plotter are described. The estimated cost of the equipment (excluding labor) is less than three hundred dollars. In operation, in the determination of several hundred isodose curves during the past 18 months, there have been no mechanical failures. Accuracy in positioning is more than adequate; and comparison with standard published values for central axis dose indicates sufficient accuracy for most clinical applications. The speed and ease of operation are such that routine isodose curves can be measured in 20 to 25 minutes. (auth)

36147 STATISTICS IN PHOTOSCANNING. Dewey, W. C.; LaRobadiere, Richard (Univ. of Texas, Houston). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 894-904(Aug. 1965).

In radioisotope photoscanning the effects of scanning speed, counting rate, light-spot size, and rate meter time constant on the quality of target detection were studied both theoretically and experimentally. Equations were developed in order to determine the best set of parameters for detecting radioactive targets located in a radioactive environment. In order to adequately detect the target, the change in counting rate which occurs as the detector passes over the target should be 2 to 3 times larger than the standard deviation of the counting rate obtained adjacent to the target. (auth)

36148 RADIUM ALIGNMENT APPLICATOR. Scott, Walter P. (Duval Medical Center, Jacksonville, Fla.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 905-13(Aug. 1965).

A mechanically simple and inexpensive applicator Ra is described which retains the innumerable good points of the loose tandem-colpostat system; it converts it into a rigid yet flexible system by first fitting the patient with the appropriate tandem and colpostats, and then aligning them at right angles to one another. Particularly in difficult pelvic anatomic situations the loose system has advantages over the rigid system, and therefore, this simple method, ensuring proper alignment, will result in the optimal application for the situation. (auth)

36149 FLEXIBLE SCINTILLATION RADIATION MEASUREMENT PROBE. Bogardus, Carl R. Jr.; Ter-Pogossian, Michel (Univ. of Oklahoma, Oklahoma City). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 914-16(Aug. 1965).

Design features are described of a flexible scintillation probe for use in direct radiation dose measurements from radioactive implants in body cavities. The probe is a valuable aid in planning the radiotherapy of cancers. (C.H.)

36150 CAN CANCER REALLY BE CURED WITH RADIATION THERAPY? Martin, Charles L.; Martin, James A.; Wilson, Robert A. (The Martin X-Ray and Radium Clinic, Dallas). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 917-23(Aug. 1965).

Multiple reports in the scientific literature proclaim that curability in certain cancers adequately treated by radiotherapy is an accomplished fact. Approximately 91 per cent of a group of cervical carcinoma cases are reported to be alive and well at 5 years. The application of this fact to the status of any individual patient on the other hand becomes a practical question. Omnipresence of the rare late, late, late recurrence of cervical cancer would seem in the strictest sense to condemn each seemingly well patient to a prolonged sentence as survivor rather than victor. Such an attitude toward the curable lesions is certainly one of misplaced emphasis. It would seem wiser to relocate emphasis in other ways. It is evident for instance that in cervical carcinoma, cure at 5 years is a reasonable accuracy, but equally evident that adequate observation should exceed that limit to at least 10 and perhaps 15 years. Each additional uneventful year in the patient's life enhances the truth value of the word cure. In a second instance, it is evident from the case study presented that significant radiation sequelae can be minimized and largely eliminated while preserving a cure rate comparable to that in other centers. Perhaps a large portion of cautious pessimism should be re-directed toward an attitude which considers significant radiation damage, even at a minimum, as inescapable. (auth)

36151 INTERNAL Sr^{90} β-RAY DOSIMETRY WITH FLUORODS. Kastner, Jacob; Roberts, Donald R.; Prepejchal, William (Argonne National Lab., Ill.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 984-8(Aug. 1965).

The use of Schulman and Etzel fluorods for in vivo and in vitro dosimetry for ^{90}Sr beta rays and other beta rays was found to be quite feasible, provided careful precalibration is carried out on a sample of the specific batch of dosimeters to be used. A reproducible technique for calibration employing gelatin phantoms is described. Comparison with the work of other laboratories can always be made if a ^{60}Co gamma-ray calibration is included. (auth)

36152 USE OF PINHOLE CAMERA FOR TESTING UNIFORMITY OF β-RAY APPLICATORS. Supe, S. J. (Atomic Energy Establishment, Trombay, India). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 989-95 (Aug. 1965).

Thin sealed beta sources, such as ^{90}Sr eye applicators, are commonly used for treatment of surface lesions in clinical work. A knowledge of the surface dose rate, the size of the active area, and the distribution of the beta flux on the surface is essential in planning treatment. The surface dose rate and the size of the active area are available from the suppliers. The measurement of the distribution of the beta flux is usually carried out by using an extrapolation chamber with sensitive current measuring instruments. Inasmuch as such equipment is rarely available in most laboratories and hospitals where these beta applicators are used, a pinhole camera suitable for studying the variation of beta flux at the surface of these applicators was designed. It was found that the defects normally associated with this technique, such as fogging of the film due to bremsstrahlung production and scattering of beta rays, could be reduced to negligible levels by choosing an appropriate material of optimum thickness for the pinhole plate and by conducting the exposures under partial vacuum. The corrections to be applied for defects arising from such factors as the tunnel effect and absorption in the thin foil covering the source are outlined. The flux variation so obtained for a ^{90}Sr eye applicator was found to be in fairly good agreement with that observed by scanning the surface through a very small size collimator coupled to an extrapolation chamber. It is concluded that important information concerning the uniformity of distribution in thin sealed beta sources such as eye applicators can be easily obtained by the use of a simple pinhole camera technique. (auth)

36153 SHIELDING DOOR WITH FLUSH THRESHOLD FOR A MEGAVOLTAGE THERAPY ROOM. Karzmark, C. J.; Huisman, P. A. (Stanford Univ., Palo Alto, Calif.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 94: 996-8(Aug. 1965).

A design objective for megavoltage therapy room doors is to limit leakage radiation at floor level without encumbering access or creating door-threshold maintenance problems. This goal is met in a new design in which the threshold is a wide deep, steel section placed flush with the floor surface. A precise narrow gap is maintained between the threshold and the undersurface of the shield-

ing door such that the radiation leakage under the door is below accepted values. (auth)

36154 OSTEOSARCOMA ARISING IN FIBROUS DYSPLASIA OF THE FACIAL BONES: CASE REPORT AND REVIEW OF THE LITERATURE. Yannopoulos, Kaity; Bom, Adrian F.; Griffiths, Cadvan O.; Crikelair, G. F. (Francis Delafield Hospital, New York). Am. J. Surg., 107: 556-64(Apr. 1964).

The occurrence of bone sarcomas arising in areas of fibrous dysplasia is rare; a careful review of the literature revealed only 11 cases, three of which involved the facial bones. About half of these patients had one or more courses of radiotherapy during treatment which as far as could be determined was in no instance beneficial. A well-documented case of osteogenic sarcoma arising in fibrous dysplasia of the facial bones in a young girl is reported. The possible role of radiation in the malignant transformation is emphasized. A review is presented of the 11 other cases of sarcoma arising in bones affected with fibrous dysplasia which have been reported. Six of the patients reviewed did not have previous irradiation. The four patients with osteosarcoma of the facial bones were all treated with radiation 7, 9, 13, and 21 yr before diagnosis of the tumor. In the case documented here, of osteosarcoma arising on the basis of fibrous dysplasia of the right facial bones, two courses of radiotherapy were given 13 and 5 yr prior to the appearance of the sarcomatous malignancy. The relation of radiation to the malignant transformation in this case is unknown; however, the association is suspected because of the known carcinogenic effects of ionizing radiation. The inadvisability of its therapeutic use in this disorder, as based on the authors' own experience and on the experience of those whose case reports were reviewed, is emphasized. Among the case reports of bone sarcoma on the basis of fibrous dysplasia reviewed, in eight who had x-ray therapy, the disease was considered by the original authors as possibly related to prior radiation. These cases include the two osteosarcomas of the mandible and tibia, osteosarcoma of the mandible, and osteogenic sarcoma of the maxilla. Of interest is the long latent period which followed radiotherapy before the onset of the malignant transformation, a condition well recognized as a prerequisite to the development of neoplasia in organized tissues in other areas of the body. This delay suggests the possibility that the therapeutic radiation may have played a significant role in the occurrence of sarcomatous changes; however, lacking an association in those patients in which it was not employed, radiation cannot be implicated in an absolute way. (BBB)

36155 THE QUANTITY OF RADIATION RECEIVED BY THE REPRODUCTIVE ORGANS OF PATIENTS DURING ROUTINE ROENTGEN THERAPY FOR ARTHROTIC JOINT DISEASE. Kettunen, Kalevi (Maria Hospital, Helsinki). Ann. Med. Internae Fenniae, 53: 161-5(1964).

Radiation therapy of joints results in incidental irradiation of nearby healthy tissue, including reproductive organs. Therefore, it seemed of value to determine the dose in these important sites when standard techniques were applied for treatment of arthrosis of the shoulder, hip, knee, foot, and finger joints and spondylosis of the cervical, thoracic, and lumbar spine. Thirty-one female and ten male patients were submitted to dosimetric studies. The following physical factors were used: 200-kv x rays with filtration equivalent to 0.5 mm Cu; 10 ma; and source skin distance 400 cm for the lumbar spine and 50 cm for each of the other fields. The treatment consisted of administering a 125 R dose, measured at the skin, three times a week, alternating between the portals about the joint. The gonad dose measurements were made by placing dosimeters at the level of the ovaries in the rectum of the female patients and on the skin of the scrotum of the male patients. The gonad doses received by male (M) and female (F) patients in a single treatment to the following sites were (in mR): cervical spine F, 11.0; shoulder, anterior F, 16.0, posterior M, 22.0, lateral F, 60.0; fingers, dorsal M, 120.0; thoracic spine F, >200.0; lumbar spine F, >200.0; hip, anterior F, >200.0; knee, anterior M, 183.0, lateral F, 136.0, medial F, 97.0, posterior M, 87.0; and ankle, posterior F, 40.0. These figures represent gonad doses without radiation shielding. Patients under 40 yr were not treated. The gonads were not directly exposed to the primary beam, but readings in the fields located in the region close to the pelvis indicate that there are gonad doses above the permissible level. The permissible dose rate for gonads is now set at 100 mR per week, measured in air. This level is primarily concerned with the problems of protection of occupationally exposed workers, and as long as only a small fraction of the population is exposed at this level, genetic effects are of secondary importance. However, it is important to consider the question of radiation hazards as involving the population as a whole. In patients who have passed the reproductive period the question of genetic hazards does not arise. The risk in the patients with joint disease is less serious because of the late age of the individuals concerned. Consequently, the problem of radiation hazards is not particularly pressing in such cases. On the other hand, a cautious attitude is necessary when consideration is given to the use of radiation for young persons. In view of the appreciable gonad doses received by the patients studied, shielding probably should be considered. (BBB)

36156 STUDIES OF THE REASON FOR THE INCREASE IN LEUCINE AMINOPEPTIDASE ACTIVITY IN URINE WITH TUMOR IRRADIATION. Bergmann, H. (Universitaet Hautklinik, Goettingen, Ger.). Arch. Klin. Exptl. Dermatol., 219: 500-4(June 25, 1964). (In German)

The kidney contains large amounts of leucine aminopeptidase. Histochemical studies have shown that this enzyme is found exclusively in the cytoplasm of cells located near the lumen of the proximal tubule. There are no detectable amounts in the glomeruli and other parts of the nephron. The appearance of leucine aminopeptidase in the serum is a sensitive indication of increased cell permeability and damage to the cells of the proximal tubule. In 300 patients with skin disease, but intact kidneys the average amount of leucine aminopeptidase in urine was 60 units/ml. Values over 200 units/ml were regarded as evidence of a pathological condition. There was no relation between serum and urine activity, and none between the activity in urine and the concentration of protein, erythrocytes, and leucocytes in urine. Studies in patients with melanomas or skin metastases suggest that decomposition products of irradiated tumors may damage cells of the proximal tubules, either directly during reabsorption, or indirectly by induction of vascular spasm in the kidney. This causes release of increased amounts of leucine aminopeptidase from the damaged cells. Thus, estimation of urinary leucine aminopeptidase is a sensitive indicator for small, reversible changes in the proximal tubules caused by the action of tumor breakdown products. (BBB)

36157 COBALTRON II, A NEW ^{60}Co MEDIUM DEPTH THERAPY APPARATUS. INITIAL EXPERIENCES WITH ADVANCED SKIN CANCER. Ehring, F. Arch. Klin. Exptl. Dermatol., 219: 504-6(June 25, 1964). (In German)

Progressive cancer of the skin and oral mucosa was treated with a 50-C ^{60}Co source, shielded so that at a distance of 1 m the dose is only 0.4 mR. The source is contained in a W-Pb shield. The source to skin distance used is from 6 to 20 cm. The shape of the applicator is adapted to the shape of the head and neck fields to be irradiated. With this equipment it has been possible to irradiate tumors that lie at depths up to 5 cm. With ^{60}Co the dose maximum lies several mm below the skin surface so that the skin is relatively unaffected. This facilitates early surgery, if desired. No side-effects are produced from this type of irradiation. It is particularly valuable for treatment of tumors that have been irradiated previously, but which have recurred later below the skin surface. It is also superior to other types of irradiation, because it produces less irradiation effect in bone. Thus, it has an additional advantage since it can be used to irradiate tumors that have invaded or grown around bone, and thus can-

not be reached effectively by other types of irradiation. (BBB)

36158 RESULTS OF IRRADIATION TREATMENT OF SKIN DISEASES WITH ^{90}STRONTIUM–^{90}YTTRIUM. Sevin, W.; Dietz, H. Arch. Klin. Exptl. Dermatol., 219: 506-9 (June 25, 1964). (In German).

The authors report results of treatment of 350 patients with 453 skin diseases, using a ^{90}Sr–^{90}Y applicator. With the applicator used the dose decreases by 50% within 1.7 mm of the skin surface. The effective irradiation effect extended to only 3 or 4 mm skin depth. Thus, this type of applicator is suitable only for skin diseases that extend no more than 3 mm below the skin surface. The irradiator contained 400 mC and had an irradiating surface of 4 cm^2. This gave a dose rate of 3250 rep/min. The diseases treated included basiliomas, spinaliomas, erythroplasias, senile keratomas, and plano-tuberose hemangiomas. Some of the patients were treated with single doses of 6000 to 8000 rep, but fractionated irradiation doses were also administered. The cure rate for the basiliomas was 96%, and it was 100% for the spinaliomas and precancerous conditions. Most of the tumors were treated with 8000 rep. The hemangiomas occurred mostly in children 3 to 9 months old. The total doses used were from 2000 to 3000 rep, and were generally given in single doses of 500 rep spaced 4 weeks apart. The irradiation times were short because of the high dose rate used. To give 500 rep required use of the irradiator for only 10 sec. The treatment was successful in 98% of the cases. (BBB)

36159 INTRAVENOUS RADIOPORTOGRAPHY: SCREENING PROCEDURE FOR PATIENTS WITH PORTAL HYPERTENSION. Grunert, R. D.; Oeff, K.; Schmidt, H. (Freie Universitaet, Berlin). Arch. Surg., 90: 237-9(Feb. 1965).

A new method of intravenous injection of isotopes and scintillation counting over the liver was devised, to replace routine splenoportography in patients with portal hypertension, which indicates all patients with a patent portal vein. Between 10 and 50 μC of hippurate-^{131}I diluted in 1 ml of saline, or any other suitable γ-ray emitting isotope, is injected intravenously. The resulting activity is measured with a scintillation counter placed over the liver. A collimator with a wall thickness of 2 cm and a depth of 10.5 cm was used. The scintillation counter was attached to a ratemeter and the latter to a linear recorder. Two phases of radioactivity over the liver are seen. The first phase is due to arterial activity in the skin, the liver, and possibly other neighboring organs; the second phase, starting about 20 sec after injection of the labeled material, is a pure portal phase. This also applies in acute interruption of the portal vein, as established in experiments on rabbits. This can only be explained by an immediate increase in hepatic arterial blood flow. Such an increase, amounting up to 80% of normal, was also observed after acute obstruction of the portal flow in man. In experiments on 6 rabbits the time from the injection of the tracer to the inception of the plateau of activity over the liver was found to be 24 ± 6 sec with the portal vein patent. It was 8 ± 3 sec when the portal vein was clamped. In each of these cases the curve of activity was biphasic in the normal animal, the second phase starting 11 ± 3 sec after injection of the isotope. Similar conditions were found in patients with chronic obstruction of the portal vein; the second phase of activity was missing in every case, and the injection-liver plateau time was less than 23 sec. Although a time interval of more than 23 sec indicated free portal flow in every case, there will be a few patients, presumably with reversal of flow in the portal system, in whom an injection-liver plateau time of less than 23 sec is found and yet the portal vein proves unobstructed at operation. Therefore, a short injection-liver plateau time (less than 23 sec) should be investigated by splenic radioportography. (BBB)

36160 A STUDY OF THE ARTERIAL CLEARANCE OF XENON 133 IN MAN. Isbister, W. H.; Schofield, P. F.; Torrance, H. B. (Royal Infirmary, Manchester, Eng.). Brit. J. Anaesthesia, 37: 153-7(Mar. 1965).

Although radioisotopes of the inert gases krypton and xenon are being increasingly used to measure regional blood flow in man, few basic observations on the distribution and elimination of these gases have been made following their administration to human subjects. Hence, ^{133}Xe (half-life = 5.2 days) was used to elucidate the pattern of the arterial concentrations of this gas after its inhalation. In anesthetized patients 1 mC of ^{133}Xe was introduced into a closed anesthetic circuit of 1.5 l[3] capacity. The patient breathed a mixture of anesthetic (halothane in oxygen) and ^{133}Xe for 6 min, after which time the circuit was opened and the patient cleared the ^{133}Xe. In the conscious patients a similar type of circuit was used. Other, conscious patients were given a rapid intravenous injection of 1 mC of ^{133}Xe dissolved in 20 ml of normal saline. Count rates were recorded over the parietal region of the skull by a directional scintillation counter. The integrated body dose of radioactivity during these procedures was calculated to be less than 0.32 mRad. In anesthetized patients the rate of arterial clearance of ^{133}Xe was relatively slow; in the manually ventilated group there was a larger standard deviation and a slower rate of arterial clearance of ^{133}Xe than in the mechanically ventilated group. In the latter group the concentration of ^{133}Xe took 3.5 min to fall to 10% of its original value (90% clearance) while in the former group this level was not reached within 5 min. In patients with normal respiratory function the pattern of arterial clearance of ^{133}Xe was similar to that found in the anesthetized and mechanically ventilated group. The effect of 5% CO_2 in these patients was to increase the rate of fall of the arterial concentration of ^{133}Xe so that 90% clearance is reached in 2 min compared with 3.5 min without CO_2. The cerebral count rates of those patients who were given an intravenous injection of 1 mC of ^{133}Xe rose to from 40 to 60 times the background activity. This level was reached rapidly and took more than 8 min to return to background levels. These results show that arterial clearance of ^{133}Xe is slow and incomplete after a single pulmonary circulation. Arterial recirculation of the gas is, therefore, significant and unless a correction is made for this the ^{133}Xe clearance technique cannot be used in a quantitative study of organ blood flow. (BBB)

36161 γ-RAY DOSIMETRY OF INTERNAL EMITTERS. II. MONTE CARLO CALCULATIONS OF ABSORBED DOSE FROM UNIFORM SOURCES. Ellett, William H.; Callahan, Arthur B.; Brownell, Gordon L. (Massachusetts General Hospital, Boston). Brit. J. Radiol., 38: 541-4(July 1965).

The method of calculating γ dose by using the absorbed fraction of emitted γ energy has been extended to include uniform distributions of radioactivity. Two cases have been considered; total-body dose for uniform distributions of radioactivity and the self-dose to organs containing activity. The dose reciprocity relation for γ emitters has been confirmed for certain geometries by direct Monte Carlo calculation. By using this reciprocity relationship the tables of absorbed fraction for point sources given by the authors previously (Ellett et al., 1964) can be used to calculate the dose at points within a uniform distribution of activity. (auth)

36162 NOMOGRAM FOR RADIOBIOLOGICALLY-EQUIVALENT FRACTIONATED DOSES. Burns, J. E. (Westminster Hospital, London). Brit. J. Radiol., 38: 545-7(July 1965).

A nomogram is presented which, using theories associated with cell-survival curves, gives directly the equivalent single x radiation dose for a given fractionated dose delivered in a given number of treatments, or any one of these quantities when the other two are known. A method of construction of such nomograms is described. (auth)

36163 THE PLACE OF RADIOTHERAPY IN THE MANAGEMENT OF EARLY BREAST CANCER: A REPORT OF TWO CLINICAL TRIALS. Cole, Mary P. (Christie

Hospital, Manchester, Eng.). Brit. J. Surg., 51: 216-20 (Mar. 1964).

Two clinical trials assessed the value of prophylactic postoperative radiotherapy and radiation-induced artificial menopause in early breast cancer. X ray treatment was given either by a technique called the quadrate or a second technique, the peripheral. The quadrate technique irradiated the breast flaps and the apex of the axilla by three tangential x-ray fields; a fourth field placed posteriorly also irradiated the axilla. The peripheral technique irradiated the apex of the axilla, infraclavicular fossa, and supraclavicular fossa by an anterior and posterior field; the parasternal area was irradiated by a separate field. The flaps were not irradiated by this technique. The results showed that there is no advantage in prophylactic radiotherapy to the patient who has had a radical mastectomy, irrespective of involvement of lymph nodes or not, provided careful follow-up of the patient, and radical radiotherapy is given at the first sign of recurrence. One-third of the control group required radiotherapy. Hence not only does there appear to be no advantage in prophylactic radiotherapy, but there is an advantage in adopting the watching policy, as at least two-thirds of the patients thereby avoid unnecessary irradiation. Some of them are already cured surgically and others have already silent widespread metastases and cannot hope to benefit from local radiotherapy. The second clinical trial was to assess the value of an artificial menopause in the management of the patient with early breast cancer. X ray artificial menopause was produced by delivering 450 R to the midpelvis by parallel opposed fields 15 × 10 cm each, using 250 kv x rays. The results are given in terms of crude survival rates at 5 yr for the whole series and 7 yr results for 98% of the series. At neither 5 nor 7 yr was the difference in survival rate between the treated group and the control group statistically significant. It therefore appears that if any increase in survival rate is to occur from an artificial menopause it must be performed at an earlier stage in the disease. When the postoperative group was subdivided into those with negative axillary nodes at the time of operation and those with positive axillary nodes, the irradiated group appeared to benefit compared with the control group whether the axillary nodes were negative or involved. Artificial menopause significantly delayed the onset of distant metastases. It is concluded that x-ray artificial menopause does significantly increase survival rate in the operable breast cancer patient. The significant difference between the irradiated and the control groups can be considerably reduced if the appropriate hormone procedures are consistently used when the disease becomes advanced. (BBB)

36164 THE USE OF ^{32}P IN THE TREATMENT OF SEVERE PAIN FROM BONE METASTASES OF CARCINOMA OF THE PROSTATE. Smart, J. Gordon (St. Thomas Hospital, London). Brit. J. Urol., 37: 137-45 (Apr. 1965).

Phosphorus-32 combined with testosterone was used in patients having bone metastases of prostate carcinomas. The treatment was particularly effective in those with osteoblastic metastases. The ^{32}P was found to be concentrated in the tumorous areas and not in the normal bone or bone marrow. Fifteen to 50% of ^{32}P is excreted in the urine and feces in the first four to six days in normal individuals. In normal persons 25 to 50% of ^{32}P administered intravenously is excreted in four to six days, mostly in the urine; a smaller percentage is excreted by patients with diseases of tissues tending to hold phosphorus such as leukemia and polycythemia. Patients with hormone-primed osseous metastases also come in the latter category and, therefore, since the maximum desirable and safe dose of ^{32}P for such patients is somewhat empirical, the intravenous route was used. The patients were given 17 daily intramuscular injections of testosterone propionate, 100 mg, and during the middle seven days of this period ^{32}P (10 mC) was administered. Estrogen therapy was recommenced a week subsequent to the last injection of testosterone. Throughout the treatment and at subsequent follow-up the amount of pain, limitation of movement, and the use of analgesics continued to be recorded. Two patients were terminal at the time of treatment, one dying just after completion of the treatment and the other a month after treatment. Both, however, had considerable relief of pain. Three patients had total relief of pain, subsequently dying of their disease between four and six months later. One case showed no response to ^{32}P therapy and died at three months. Of the remaining three cases, two had 90% relief. The literature is reviewed and the results compared with other therapeutic measures. It is concluded that ^{32}P therapy may result in the total or marked relief of the pain from bone metastases from carcinoma of the prostate for a period of months and that more extensive trials are indicated. (TCO)

36165 ISOTOPE ENCEPHALOGRAPHY: EXPERIENCE WITH 100 CASES. Bull, James W. D.; Marryat, John (Inst. of Neurology, London). Brit. Med. J., 1: 474-80 (Feb. 20, 1965).

Studies were carried out with a Picker Magnascanner and the isotope used in the first 100 cases was ^{203}Hg-chlormerodrin (Neohydrin). Patients were selected only to the extent that those under the age of 18 yr were exluded on the grounds of possible radiation damage to the kidneys. All the cases examined were suspected clinically of having an intracranial mass. The patient was prepared 24 hr before receiving the isotope with an intramuscular injection of 1 ml of meralluride to reduce the uptake of the isotope by the kidneys and thus reduce the renal radiation dose. Early on the day of the examination the patient received an intravenous injection of 10 μC/kg, body weight of ^{203}Hg-chlormerodrin, with a max dose of 700 μC, irrespective of excess weight. The scan (which takes two hr) was started five hr after injection. The renal radiation dose is estimated at 59 to 60 Rad. For this reason no patient was scanned more than once with this substance. When follow-up scans were indicated they were undertaken after a suitable interval with an isotope giving less radiation to the kidneys. Interpretation of the scans is outlined. There were 53 positive scans, and all these patients appeared to have lesions. There were 42 negative scans; of these, 22 were probably truly negative. The remaining 20 were proved to be false, that is, these patients harbored tumors not demonstrated by the method. The causes of the false negatives are discussed. Since a positive scan always denotes a lesion and scanning is painless and free from risk, this investigation should be made before angiography and/or pneumography. Possible means by which tumors and other lesions such as abscesses, hematomas, and cysts selectively absorb isotopes is discussed. (TCO)

36166 CANCER OF THE BLADDER: COMBINED 5-FLUOROURACIL AND COBALT-60 TELETHERAPY. Kaufman, Joseph J.; Langdon, Edward A.; Stein, Justin J.; Burt, Frederick B. (Univ. of California, Los Angeles). Calif. Med., 101: 334-40(Nov. 1964).

Because of unsatisfactory results with preoperative use of high doses of supervoltage irradiation, and in recognition of the reported synergism of 5-flourouracil (5-FU) and ^{60}Co γ irradiation, a program of combined chemotherapy and supervoltage irradiation was tried in an effort to halt growth of tumors and minimize postoperative complications. Results and complication with the present and earlier series are reported. Thirty-two patients were divided into two groups: those treated with an average total dose of 4000 mg of 5-FU and 3000 R of ^{60}Co γ rays and followed by operation, and those who had stage D bladder tumors or who refused operation. In the latter cases an average total dose of 6000 mg of 5-FU and 5500 R of ^{60}Co teletherapy was used. Cobalt-60 treatment was fractionated as 300-R skin doses per treatment for three to seven weeks, five days a week. Of the complications observed, only five could be considered serious. One patient required treatment in hospital for dehydration secondary to diarrhea, and four patients required blood transfusions for severe hematuria. Nausea and vomiting were usually controlled with antiemetic agents, and paregoric and bismuth usually alleviated diarrhea. Severe cases of diarrhea required

interruption of therapy. In most of the cases in which 5-FU therapy was permanently discontinued, intractable diarrhea was the reason. Leukopenia did not occur in any of the patients. Stomatitis occurred twice, but alopecia was not noted. Of 13 patients with infiltrating bladder carcinoma and no demonstrable metastasis, nine have shown no evidence of residual tumor either in the surgical specimen or on repeated cystoscopic evaluations. These results compare favorably with results after supervoltage radiation alone (38% apparently tumor-free and 19.5% of surgical specimens showing no tumor). In addition, the surgical complication rates after treatment by 5-FU and ^{60}Co teletherapy were significantly lower than those seen following supervoltage therapy alone in high dosage. They were as low as can be expected from surgical operation alone. It is concluded that definite advantages can be achieved by the combination of chemotherapeutic-radiotherapeutic regimen. Early results are encouraging and absence of serious complications either from the combination therapy itself or from the surgical procedures following combination therapy have been few. Patients who have already received maximal radiation therapy respond poorly to combination treatment. Previous irradiation therapy causes endarteritis and poor oxygenation of the bladder and its contiguous structures, and these conditions reduce the efficacy of 5-FU and additional irradiation therapy. (BBB)

36167 A NEW TECHNIC FOR THE DETECTION OF LEFT-TO-RIGHT CARDIAC SHUNTS BY USE OF AN ESOPHAGEAL GEIGER-MULLER TUBE. Ira, Gordon H. Jr.; Orgain, Edward S. (Duke Univ., Durham, N. C.). Circulation, 31: 95-102(Jan. 1965).

In this new radioisotope technic for the detection of left-to-right circulatory shunts a miniature G-M tube is placed in the esophagus behind the left atrium and positioned by the electrocardiogram. In this position the G-M tube measures radioactivity from the left atrium. Curves are then recorded simultaneously from the precordium, lung, and left atrium. Methods of injection, monitoring, and recording are presented that provide greater diagnostic accuracy over those external detector technics currently in use. The isotope, ^{131}I-labeled hippuric acid, is administered in conventional dosage of 50 to 75 μC per injection. Usually only one injection is necessary but three injections of 150 μC have been given without danger of overexposure. Two scintillation detectors with 2-in. crystals are used with two analytical rate meters. Collimation for the scintillation detectors varies with the areas monitored. A 20° flat-field collimator is used for precordial curves and a 1-in. straight-bore collimator is used for the peripheral and lung curves. The esophageal detector is a miniature γ-ray-sensitive halogen tube placed on the end of a shielded cable 5-mm in width. The characteristics of the G-M tube are described with reference to a diagrammatic representation of the chest cut horizontally through the left atrium and esophagus. The percentages of counts that are picked up from a source placed at certain distances from the G-M tube are given at 1-cm intervals. The 50% circle is between 2 and 3 cm away from the esophagus and the left atrium contributes most of the radiation source. With use of the technic a small bolus of the isotope is injected rapidly into the vein. The resultant curve is usually clear-cut in spite of the peripheral injection site. With each injection the precordium, the lung, and the left atrium are monitored and recorded on a direct writer, an oscilloscopic recorder, and on magnetic tape. The record from the direct writer possesses the advantage of immediate availability. The photographic oscilloscopic record produces three simultaneously recorded curves superimposed on the same time scale. This permits comparative timing of the various peaks and slopes of the curves. Of 23 patients studied, 11 presented left-to-right shunts. Seven of the 11 shunts were detected by both precordial and esophageal technics. Four of the 11 shunts were missed by conventional precordial technics but were correctly diagnosed preoperatively by the esophageal detector. Although the accuracy of any radioisotope detection technic with external counting may not approach that of direct cardiac catheterization, this method, because of its relative simplicity and accuracy, is useful in the demonstration of left-to-right shunts both preoperatively and postoperatively. (BBB)

36168 TREATMENT OF INOPERABLE BRONCHIAL CARCINOMA BY A COMBINATION OF CHEMOTHERAPY AND IRRADIATION. Gollin, F. F.; Ansfield, F. J.; Vermund, H. (University of Wisconsin, Madison). Deut. Med. Wochschr., 89: 2140-6(Nov. 6, 1964). (In German)

Patients with inoperable bronchial carcinoma were treated with a combination of a projected minimal dose of 4000 to 5000 R of x irradiation, administered over 4 or 5 weeks, and 5-fluoruracil. In some patients treated with irradiation alone, the average total dose was 4075 R. In 4 patients the minimal dose was not given because of side-effects produced. In the group given combined treatment, only 5 out of 13 received 4000 R or more, so that the average dose in this group was 3415 R. Two patients who survived the treatment for only one month apparently died of toxic effects of the irradiation. With irradiation alone the average survival time was 6.2 months, but with irradiation plus 5-fluoruracil it was 18.1 months. Another group of 7 patients was given a combination of fractionated x irradiation and cyclophosphamide. Only two of these received as much as 5000 R, and the average dose was 4911 R. The average survival time for these patients was 6.8 months. When 5-iodo-2'-deoxyuridine was compared in treatment combination with irradiation, the average survival time was 4.0 months. Comparison of the dosage rates suggested that 5-fluoruracil with irradiation was more effective than irradiation alone to increase survival rates. 42 references are cited. (BBB)

36169 PROGRESS OF A MARKER IN THE LARGE INTESTINE. Ramsay, Gordon S. (Chester Beatty Inst. of Cancer Research, London). Diseases Colon Rectum, 8: 74-5(Jan.-Feb. 1965).

A method of monitoring continuously the progress of a radioactive marker through the colon is described. It is designed to study transit through the colon in such diseases as ulcerative colitis, diverticulitis, and cancer. It is also intended to determine if there is a correlation between the sites where progress of the marker is delayed and those where cancer occurs most often. The method permits complete freedom of movement of the patient, within the limits of the ward, using a minimum amount of apparatus. The technic is aimed at detecting a radioactive source of very low activity by four G-M tubes held in position by a belt in the region of the cecum and the hepatic, splenic, and sigmoid flexures. Pulsations from each of these counters are telemetered and a continuous record is made of the counting rate in each detector. By relative counting rates in different channels, movements of the marker can be followed. An estimate can be made of its position at a given time, and transit time between specific points can be measured. Difficulties caused by variation in the disposition of the colon of different subjects can be overcome by using four G-M counters. Cobalt-57, a pure γ emitter which can be obtained at relatively high sp act., was chosen as the source. A tablet containing 20 μg is placed in the middle of a Perspex sphere (1.3 cm in dia) which is swallowed. The dose rate at the surface of the sphere is 38 mR/hr and it falls off rapidly with distance according to the inverse square law. The activity of this source is such that no special precautions are necessary for its handling or disposal. In comparison, in an x-ray film of the abdomen, the dose to all parts of the gut will be about 40 mR/hr. The telemetry system operates as follows: each G-M tube triggers a separate pulse generator, the output pulse having a duration of different value for each tube. The pulses modulate the transmitter and, at the receiver, decoding circuits separate the pulsations, each length into its own channel, and feed the counting rate information to four recording rate meters. (BBB)

36170 OBSERVATIONS ON RADIATION INJURIES OF THE FACE AND JAWS. Pfeifer, Gerhard; Guenther, Horst. (Universitaetsklinik, Hamburg-Eppendorf, Ger.).

Fortschr. Kiefer-Gesichtschir., 8: 29-36(1962). (In German)

The occurrence of severe radiation injuries about the face is reported for patients receiving radiation for tumors, and in many cases benign diseases. Follow-up examination of 402 patients so treated at the Westdeutsche Kieferklinik, Hamburg showed irreversible changes in 159 patients. In 43 cases there was serious damage, particularly with disturbances in development of the face, jaws, or teeth. A discussion is given on the biological effects produced by the use of ionizing radiation. A statistical analysis was made of the clinical material, classified according to the distribution of radiation effects in various diseases with reference to various types of manifestation and localization of the irradiated areas. The effects of radiotherapy are discussed by reference to brief case histories demonstrating typical and extreme examples. Surgical correction following irradiation in adults is usually satisfactory, even in severe cases. However, when there has been a radiation-induced disturbance of development, correction is difficult and often must remain incomplete even after extensive operative procedures. Maldevelopment of bones in several children is described. These late results therefore emphasize the need for careful consideration of the indications for radiation treatment during childhood even in radiosensitive conditions. The results of irradiation, particularly in the maxilla and temporomandibular joints, may only become manifest much later as severe functional cosmetic deformities. (BBB)

36171 THE USE OF RADIO-IODINE IN THE REDUCTION OF EUTHYROID GOITRES. Keiderling, W.; Emrich, D.; Hauswaldt, Ch.; Hoffmann, G. (Universitaet, Freiburg i. Br., Ger.). German Med. Monthly, 9: 265-9(July 1964).

Treatment of 379 patients with euthyroid endemic (as opposed to toxic nodular) goiter by ^{131}I is described, along with reasons for using radiation, administered doses, absorbed radiation doses, complications, and results. The incidence of endemic goiter was particularly high in the older patients, in whom the genetic risk of radiation could be disregarded. To achieve a definite reduction in the size of the gland it was usually necessary to give a dose of radiation of 15,000 to 18,000 rad/g of thyroid tissue. The treatment was repeated after three to four months if inadequate results were achieved with the first treatment. A total of 60% of patients received one therapeutic dose and 30% received two therapeutic doses of radioiodine. The remaining patients required more than two doses and one was given six. Three-quarters of the patients received an average single dose of up to 20 mC. The total dose did not exceed 40 mC in 85% of patients. The high therapeutic doses used in a few patients are explained by some patients with inoperable giant goiters exceeding 200 g in weight. The therapeutic dose was given orally. Patients with marked narrowing of the tracheal lumen were given prophylactic prednisone to prevent further narrowing of the trachea which might result from radiation thyroiditis. The patients were kept in hospital for four to six days after receiving radioiodine, partly as a radiation-protection measure. Follow-up examinations were carried out at six- to 12-month intervals. Improvement was seen in about two-thirds of all patients as a result of treatment. The estimated weight of the thyroid decreased by 20 to 75 g in 63% of patients. In an occasional patient the estimated loss of thyroid gland weight was up to 100 g. A marked decrease in the circumference of the neck (4 to 8 cm) was seen especially in patients who had suffered from obstructive conjestion before treatment. One third of all patients showed no significant improvement after radioiodine. Only 12 patients had increased thyroid enlargement or an increase in the circumference of the neck. Two patients had recurrences one and five years after treatment respectively. The overall incidence of side-effects of radioiodine was low. About 5% of patients developed mild radiation thyroiditis, which usually subsided within the first 14 days after radioiodine administration, generally without treatment. Two patients who during radioiodine therapy developed acute dyspnea as a result of further marked narrowing of an already softened trachea had to have a tracheotomy. General symptoms of mild radiation sickness occurred in 13% of patients. Clinical manifestations of hypothyroidism were observed in only five of the 379 patients treated (1.6%). The hypothyroidism in these patients was mild. Symptoms were completely relieved by substitution therapy with 20- to 40-μg doses of triiodothyronine. Four patients who developed hypothyroidism had recurrent goiter after previous thyroidectomy; four had to be given several doses of radioiodine before the desired therapeutic effect was achieved. In another 21 patients, radioiodine function tests carried out two to five months after treatment revealed a reduced iodine uptake of less than 20% without clinical manifestations of hypothyroidism. Further follow-up studies are needed to determine whether these patients will later develop overt hypothyroidism similar to the late hypothyroidism which may follow radioiodine therapy in thyrotoxicosis. Further studies over a longer period are needed to assess the incidence of late myxedema. Total-body radiation dose with radioiodine therapy was ~9 rem on the average and thus corresponded to doses used in x-ray examinations of abdominal organs. Since radioiodine therapy offers conservative reduction in size with almost negligible side-effects, it appears to be the method of choice for recurrent goiter and in patients over the age of 30 yr with goiters which are either inoperable or which involve an increased operative risk. (BBB)

36172 PRINCIPLES OF RATE MEASUREMENTS IN RELATION TO THE RADIOISOTOPE RENOGRAM AND THE THYROIDAL UPTAKE TEST. Taplits, Sol (Jewish Hospital, Cincinnati, Ohio). J. Am. Geriat. Soc., 13: 429-41(May 1965).

A discussion of the principles of rate measurements in radioisotope studies led to the conclusion that in determination of concentration or excretion rates by radioisotopic measurements, the dose is a variable that must be overcome when recording continuously. By recording radioactivity in percentage terms, this variable is eliminated. These observations are based on the principles that any target organ that specifically or selectively concentrates or excretes does so according to a fixed ratio, and the rate of accumulation of the injected radioisotope is proportional to the dose. The scales of a rate meter can be used for recording of the radioactivity data as a fixed ratio or percentage. The results are quantitative, reproducible, and consistent. When recording percentage by the scales of a rate meter, the dose variable is eliminated so that the tracing truly indicates function. Other variables that affect the counts were eliminated by means of a phantom (simulating the depth, tissue density, position, and size of the target), within which the dose was measured at the same distance as the target organ. However, collimation must include the target organ and exclude extrinsic radiation from other parts. Other methods of measuring similar ratios may be used if appropriate scales are not available. These principles were illustrated by measurement of thyroid ^{131}I uptake and by the radioisotope renogram. The dose, preparatory to injection or ingestion, is placed in the phantom and radioactivity is counted at a fixed distance that will subtend a solid angle to encompass an area that will include the entire organ but exclude the other parts. At this fixed distance, the dose representing 100% (a full deflection on a 100 K scale of the rate meter), the scale is changed to 20 K. This scale for recording function then will represent 20% of the dose, and each division will represent 2%. In the immediate thyroidal ^{131}I uptake test a fixed ratio of 0.2, or a full scale deflection of 20%, was used consistently. Within 15 min, the rate of accumulation of radioactivity was recorded. The change of the slope represented the change in thyroidal function. When these principles were applied to the radioisotope renogram, instead of the usual dual systems, an adapter was used. Thus both kidneys were simultaneously monitored by means of a single detector rate meter, chart recorder, and pulse height analyzer. The adapter consisted of a reciprocating mechanism that shielded the kidneys alternately at regular intervals so that two discontinuous curves were recorded which simulated

the curves usually obtained in the ordinary renogram. Furthermore, the tracing recorded the percentage, directly and quantitatively. Another method described involves two injections within 15 min, shielding the kidneys alternately with lead. The first dose is about 20 μC and the second is about 5 times the first. In both cases, however, the ratios are the same; the difference is only in the magnitude of the scales used. When the ratios are the same, the curves are reproducible for the same kidney, even though the doses are different. (BBB)

36173 A HISTOPATHOLOGIC STUDY OF CARCINOMA OF THE UTERUS FOLLOWING IRRADIATION FOR DYSFUNCTIONAL UTERINE BLEEDING. Vakil, Vatsala V.; Sirsat, M. V. (Tata Memorial Hospital, Bombay). Indian J. Med. Res., 52: 368-75(Apr. 1964).

Tissues were examined in four cases of uterine carcinoma having previous histories of irradiation. Special attention was given to changes observed in the connective tissues in relatively uninvolved portions of the uterus subjacent to the carcinoma. The initial complaint for which radiotherapy was instituted was abnormal uterine bleeding, menorrhagia, or menstrual irregularity. The time interval between irradiation and the development of carcinoma was 10 and 20 yrs. Two patients were treated initially by intracavitary radium followed one or seven years later with deep x ray; another with deep x rays alone, and the mode of irradiation was not known for the remaining case. The stromal changes, studied by a variety of staining techniques, consisted of hyalinized fibrosis of the myometrium and marked hyaline thickening of the blood vessels, with narrowing or even complete obliteration of the lumina. Subepithelial collagen in the cervices showed hyalinization and fragmentation. There was a quantitative increase in the elastic tissue in the myometrium associated with fragmentation in the form of irregularly scattered, tangled masses. The cervices also showed hyperplasia of the elastic tissue and fragmentation beneath the stratified squamous epithelium with a complete disappearance in the region of the carcinoma. The alterations in the collagenous tissue and the blood vessels were believed to be specific radiation changes as they were absent in nonirradiated control specimens. It is concluded that these stromal changes lead to a marked deterioration in the nutritional status of the overlying epithelium and thereby may promote its malignant transformation. It is suggested that it is highly probable that the radiation treatment was the cause of the development of the carcinomas. (TCO)

36174 USE OF THE SCINTILLATION CAMERA TO REDUCE RADIOISOTOPE SCANNING TIME. Gottschalk, Alexander; Anger, Hal O. (Univ. of Chicago). J. Am. Med. Assoc., 192: 448-52(May 10, 1965).

Instrumentation, clinical applications and results, and advantages of this technique over standard scanning methods are described. The scintillation camera represents an instrumentation breakthrough that permits a reduction in examination time often to one-tenth or less the time needed by the conventional scanner. It produces pictures of the distribution of the radioisotopes without the necessity of mechanical scanning, and is continuously sensitive to all parts of the field of view during the entire exposure time. The γ-ray version of the scintillation camera contains the following parts. First, a collimator projects a γ-ray image of the subject onto a large, sensitive fluorescent NaI crystal. When γ rays interact with the crystal, they produce flashes of light that are detected by an array of 19 multiplier phototubes, each of which views overlapping areas in the crystal. The light from each scintillation divides among the phototubes and a computer determines the location of each scintillation in the crystal. The scintillations are displayed as flashes of light on a cathode-ray oscilloscope. By taking a time exposure of the oscilloscope with self-developing film, an image of the subject is built up from the flashes that occur. Each flash appears as a white dot on the resulting print. Renal scanning with chlormerodrin-^{203}Hg can be readily accomplished with the scintillation camera by use of a multichannel collimator. The 9- to 10-in. field of view is large enough to include both kidneys in 90% of adults. Since the exposure time needed to obtain excellent renal scintiphotos is three to five minutes when the usual scanning dose of 100 μC of chlormerodrin-^{203}Hg is used, it is a quick and simple procedure to film both kidneys separately if necessary. The sensitivity of the scintillation camera permits a marked dose reduction when desired. For example, renal scintiphotography has been effectively performed in a 9-year-old child with only 5 μC of chlormerodrin-^{203}Hg and a 15-min exposure time. The smaller dose is possible because of the smaller kidneys and decreased tissue attenuation in children. The renal irradiation in this case was less than one rad. When conventional brain tumor agents, such as chlormerodrin-^{203}Hg are used with the scintillation camera, pictures can be made in five min when the usual scanning dose of 10 μC/kg of body weight is employed. EDTA labeled with the short-lived positron-emitter ^{68}Ga is a satisfactory brain scanning agent when used with the positron scintillation camera. In over 100 tumor suspects, 32 proved brain tumors were present, and 27 (84%) were correctly localized with gallium edetate-^{68}Ga. Since the effective half life of the tracer compound is only about 45 min, a dose of 700 μC of gallium edetate-^{68}Ga gives a total-body radiation dose of only 30 Mrad, and a renal dose of 150 Mrad. Use of the scintillation camera with conventional brain scanning agents permits reducing exposure times to at least one-tenth those needed with a conventional scanner. Moreover, with the short-lived γ emitter ^{99m}Tc, diagnostic scintiphotos have been taken in 10 to 30 sec. By the use of positron-emitting ^{18}F, bone lesions can be rapidly visualized with the positron scintillation camera. With a 100-μC dose of rose bengal-^{131}I, only a five-min exposure is required to obtain pictures of the adult liver. (BBB)

36175 SELECTION OF AN AGE LIMIT IN THE RADIOACTIVE IODINE TREATMENT OF THYROTOXICOSIS. Stanbury, John B. (Massachusetts General Hospital, Boston). J. Med. Assoc. Georgia, 53: 101-6(Mar. 1964).

Attempts are made to assess the possible hazards of radioiodine therapy and to weigh the risks against the benefits. In ^{131}I therapy of thyrotoxicosis a dose of radiation is delivered to the thyroid which is comparable to or exceeds that which causes neoplastic changes in other tissues. Nevertheless, in spite of 22 years of experience, neoplastic changes in the thyroid attributed to ^{131}I have not appeared in significant numbers. The same can be said for leukemia. An estimate of the genetic consequences of radioiodine treatment is made. An eight-rad dose is delivered to the whole body by a 10-mC dose of ^{131}I given to a patient with the average uptake and turnover of Graves' disease. The gonads receive about half of this dose; four rad is ~4% of the doubling dose for mutations. It is estimated that the risk of thyrotoxicosis in the population at large is about 1.4%. The product of this risk, the fraction of the doubling dose and the natural mutation rate, in addition to the natural birth defect rate is 0.0000056. This means that, if, throughout all future generations, all patients are treated with ^{131}I, about 56 additional recognizable mutational changes would be expected out of the 400,000 defects which appear in every ten million births. Considering the mutational risk in the first generation progeny of a patient treated with ^{131}I, the additional risk becomes 0.00008. That is, two out of every 1000 birth defects would be mutational due to ^{131}I alone, in addition to the natural rate of four out of every 100. These mutational changes are not necessarily lethal, or even dangerous, but it is assumed that most mutations are harmful. This genetic risk must be balanced against risks of anesthesia and surgery, as well as against the morbidity involved in a surgical procedure. It is concluded that radioiodine therapy of thyrotoxicosis will impose a moderate but real genetic burden on the population as a whole, and particularly, on the descendants of the treated patient. Therapy with ^{131}I causes no discernible effect on the parathyroids, larynx, kidney, stomach, or any other organ, other than the gonads and thyroid. Myxedema, occurring both early and late after ^{131}I therapy, is emerging as the most serious consequence to radioiodine therapy. Older patients who discontinue or

neglect the treatment of myxedema may fall into a fatal state of myxedema. The mortality in this group is high. It is suggested that all patients with Graves' disease above the age of 25 may be treated with ^{131}I, but that this should only be done if a full and careful follow-up of the patient is possible for many years and strictly adhered to. If this is impossible, chronic antithyroid drug therapy or subtotal thyroidectomy should be instituted. (BBB)

36176 CLINICAL APPLICATIONS OF LOW-ENERGY HIGH TRANSMISSION COLLIMATOR. Goodrich, Jack K. (Univ. of Mississippi, Jackson); Stone, H. L.; Harris, C. C.; Hill, Rebecca. J. Nucl. Med., 6: 409-20(June 1965). (ORNL-P-981)

Nineteen hole collimators were compared to 109 hole collimators in scanning experiments. It was concluded that body organ scanning requires a choice of both isotopes and detector-collimator combinations tailored to fit a specific diagnostic task. (H.G.D.)

36177 SUPRAVOLTAGE IRRADIATION FOLLOWED BY CYSTECTOMY FOR BLADDER CANCER. Galleher, Earl P. Jr.; Young, John D. Jr.; Beyer, Otto C.; Bloedorn, Fernando G.; Dow, James (Univ. of Maryland, Baltimore). J. Urol., 93: 598-603(May 1965).

Surgical removal of the irradiated bladder was conducted in 22 patients with vesicular tumors, with attention to optimal doses, occurrence and prevention of complications, and the most favorable interval for surgical intervention in irradiated tissues. Invasive bladder tumors (stages B and C) were irradiated with telecobalt. In well-differentiated tumors, without extravesical extension, rotational therapy to the entire bladder was used aiming at a dose of 6000 Rad in 5 weeks. For anaplastic tumors and tumors with extravesical extension and after transabdominal surgery, total pelvis irradiation was used to a tumor dose of 4500 Rad in 4½ weeks followed by additional radiation to the bladder up to 5500 to 6000 Rad in 5 to 6 weeks. Radiation reactions were kept to a minimum by careful localization of the bladder, proper dosimetry with isodose mapping of the volume irradiated, and periodic evaluation. Radiotherapy was followed by total cystectomy at intervals of 1 to 42 months. Postirradiated excised bladders from all 22 patients were studied, nine by serial sections. Histopathological findings at cystectomy were correlated with length of time following ^{60}Co irradiation. Ten of the 21 patients had no complications following irradiation and cystectomy; in four, intestinal fistulas developed; and the wound dehisced in three patients. Fourteen (63.6%) patients who underwent irradiation are living and well from two to 46 months following cystectomy. Two died of subsequent complications with no evidence of residual tumor at autopsy. One died of an unknown cause six months following cystectomy. Metastatic disease was proven by autopsy in only one patient. The brief follow-up period prevents any determination of survival rate of bladder cancer patients treated by the previously described method; however, the results indicate that cystectomy following irradiation is feasible and well-tolerated. The complication rate compares favorably with that reported for radical total cystectomy alone. Supravoltage irradiation of these bladder neoplasms converted positive tumor tests to negative in six patients and changed masses to induration only in two others. The tumor was completely eradicated in six bladders (27.2%). This report justifies continuation of the combined treatment regimen for invasive bladder tumors. Modifications, such as pre-irradiation urinary diversion, might reduce complications. This is especially true in the patients with renal damage, fixation of the tumor, gross urinary infection, decreased bladder capacity, and bladder neck obstruction. The irradiation effect is contingent upon intact blood supply; therefore, the concept of interrupting therapy for cystectomy and completing the radiation post-operatively is not valid. It is suggested that an uninterrupted dose of 6000 Rad followed by a 6- to 8-week waiting period results in maximum tumorcidal effect and renders the bladder in its most operable stage. The chance of operative local and distant seeding of the tumor is also decreased. The 6- to 8-week waiting period is optimum since the acute reaction of irradiation subsides in this interval, while the chronic reaction of fibrosis and arteriolar obliteration has not yet begun. (BBB)

36178 THE INVESTIGATION OF THE DESIGN AND EXPERIMENTAL PROPERTIES OF MULTICHANNEL FOCUSSED COLLIMATORS USED IN GAMMAGRAPHY. Husak, Vaclav; Kleinbauer, Karel; Wiedermann, Milos. Jaderna Energie, 11: 170-β(May 1965). (In Czech)

The design concepts of multichannel and focused collimators used in gammagraphy are summarized. Two different focused collimators were compared with one-hole cylindrical collimators from the point of view of resolution, sensitivity, and contrast. In the case of the same sensitivity, the focused collimators had better resolution than the one-hole collimators, and gave better contrast in the gammagraphic record, etc. In the choice of a collimator, the resolution and sensitivity of the collimator and also the dimensions of the pictured area must be taken into account. The focused collimators are considered necessary for achieving good gammagrams in clinical practice. (auth)

36179 MEGAVOLT RADIATION THERAPY OF CANCER: SOME CONCEPTS OF FIELD SHAPING AND PROTECTION OF VITAL STRUCTURES. Smedal, Magnus I.; Salzman, Ferdinand A.; Wright, Kenneth A. (Lahey Clinic Foundation, Boston). Lahey Clin. Bull., 13: 121-7(Jan.-Mar. 1964).

The special techniques described are divided into two categories: field shaping and special protection. Field shaping has two objectives: that of adjusting the shape of the beam of radiation to the known tumor volume and its possible zone of extension and that of protecting adjacent normal areas by excluding the latter from the beam. Special protection is important when a vital structure for which partial or total protection is necessary lies within the treatment volume. Rotational treatment of carcinoma of the thyroid is used to illustrate field shaping and special protection. A special protective device (usually a lead rod ⅛ in. in dia) is shaped to conform to the cervical spinal curvature. To shield the spinal cord during treatment this device rotates synchronously with the patient. This is accomplished with the aid of a small motor mounted on the x-ray generator face plate and synchronized with the rotating treatment chair. The patient and cord protector require approximately three to four revolutions for the daily administered tumor dose of 175 R; the dose to the spinal cord is reduced to ~50% of this tumor dose. For treatment of eye tumors, by using rotational techniques, a more homogeneous distribution of radiation in the tumor volume is achieved, and the lens of the eye is shielded simultaneously by the interposition of suitable absorbers. In the usual situation of tumors near one eye, the technique is modified by having the patient rotate around an axis which passes through the lens of the eye near which the tumor is situated. This allows interposition of a fixed or nonrotating protective device in front of that eye because it will remain in the same relative spot in the treatment field throughout the period of treatment. A special protection problem was also solved for the kidneys whereby two separate structures within the treatment field can be protected during rotation, even though the axis of rotation, unlike the example of the eye, does not pass through either of them. (TCO)

36180 MEGAVOLTAGE THERAPY IN CARCINOMA OF THE BLADDER. Finney, R.; Jones, H. C. (Newcastle General Hospital, Eng.). Lancet, 2: 580-2(Sept. 22, 1962).

Complications developing as a result of 4-Mev x-ray treatment of bladder cancer in 160 patients are described. In radical treatment the whole bladder was irradiated with a three-field technique (one anterior and two posterior-oblique fields), the field sizes being about 8 × 8 cm. Each field was treated daily for five days per week, with a total tumor dose of 6500 Rad. Because preliminary studies on dose suggested that reactions were excessive after too rapid a dose rate, the daily dose was 200 Rad (tumor dose), the total of 6500 Rad being achieved in just over six weeks.

The preliminary survey indicated that the reactions, especially proctitis, are worse with a higher daily dose rate. In palliative therapy, using two opposed fields, the field size was increased so that any extravesical spread was included, with the bladder, in the irradiated volume. The field size was ~10 × 10 cm, and the doses about 2500 Rad in seven days, or 3500–4000 Rad in 14 days. The overall results for radical megavoltage therapy, which was given in 141 cases, showed that 30 (22%) survived tumor free. As expected from the physical characteristics of x rays, skin reactions were negligible, amounting only to a mild erythema. Some women with obese abdominal walls had late post-irradiation skin changes in the suprapubic zone (subcutaneous edema and fibrosis), but the morbidity was slight. General effects were few, occurring in <10% of patients, who complained of slight nausea, anorexia, or general malaise. Local pelvic effects were more common, but these reactions were less severe and less frequent than those which follow conventional x-ray methods. Urinary frequency became worse in about 50% of cases, and in half was severe. In less than 20% was there hematuria after the 3000-Rad tumor dose had been reached (i.e., roughly after the halfway stage). With the radical dosage employed, rectal reactions were not serious. They occurred in less than a third of the cases, their severity was graded as mild, and they all responded to simple diarrhea mixtures. At the higher dose rate given with palliative treatments, in which the rectum received as high a dosage as the bladder, rectal reactions were far more severe. Diarrhea, tenesmus, and colic usually persisted for one to two weeks after the completion of treatment, and then resolved completely. In one case, with a history of anorectal infection, which was irradiated radically, there was permanent anorectal ulceration and stricture. With the frequency and dysuria there was usually an immediate reduction in bladder capacity, and then a gradual improvement within three to six months, the greatest improvement being within the first month. The late effects in the bladder could be observed only in patients who survived for a reasonable time, and of 30 such cases, in 21 the capacity was normal within six months of the end of treatment and remained so. In seven cases the capacity became permanently reduced to 10–12 oz, and in five cases to 4–8 oz. In these the initial radiation reactions were severe, and the bladder capacity was reduced to about 4 oz immediately after treatment. After radical megavoltage therapy the bladder mucosa apparently passed through several stages, ending either as relatively normal tissue or one showing much postirradiation change. The immediate effect on bladder mucosa, as observed at cystoscopy, was usually hyperemia, in some cases associated with infection. Later there was patchy edema of the mucosa, in places raised in thick folds. In two patients cystectomy was necessary for persistent bleeding. Contrary to expectations, after megavoltage therapy pelvic fibrosis was relatively slight compared with the dense adhesions from conventional x-ray therapy. This may be a radiobiological effect, or simply the effect of a decrease in the volume of tissue irradiated. There was some delay in wound healing in some cases, but this was not a serious problem. The histologic changes in bladder studied in 20 patients who were subjected to cystectomy after megavoltage therapy are described. The most striking change was in the submucous layer, which was always occupied by fibrous tissue. The muscle layers showed varying degrees of atrophy and fibrous replacement, and foci of inflammatory cells scattered throughout the muscle were noted. (BBB)

36181 RADIOACTIVE PHOSPHORUS TREATMENT OF BONE-METASTATIC CARCINOMA OF THE PROSTATE. Smart, J. Gordon (St. Thomas's Hospital, London). Lancet, 2: 882-3(Oct. 24, 1964).

A combination of ^{32}P and testosterone was used to give striking symptomatic improvement, measured by relief or abolition of pain. The rationale of the treatment is based on the greater uptake of radioactive phosphorus by embryonic and neoplastic tissues than by other tissues, and on the increased uptake of phosphorus in new bone after the administration of androgens. Autoradiography has confirmed that when ^{32}P is given in conjunction with testosterone it becomes concentrated in the tumorous areas and not in the normal bone or bone marrow. The patients were taken off stilbestrol therapy for a week before treatment, and 17 daily intramuscular injections of testosterone propionate were then given. For the middle 7 days of this period 1.43 ml of ^{32}P solution with an activity of 10 mC on day 1 was injected intravenously; ^{32}P having a half life of 14.3 days, the total dosage was 8.68 mC. At the conclusion of this course of treatment the patients resumed the taking of stilbestrol. The four patients so treated were relieved of pain from the tumor metastases. Most of these patients were within a year of their death. This treatment, which provided symptomatic relief for much of the remainder of the patient's life, is worth further trial, particularly since it avoids the risk associated with surgical operations, such as adrenalectomy or pituitary implantation. (BBB)

36182 SOME USES OF THOROTRAST. Foxon, G. E. H. (Guy's Hospital Medical School, London). Med. Biol. Illus., 11: 22-6(Jan. 1961).

Some of the uses to which Thorotrast can be put are described. The passage of the Thorotrast through the heart may be recorded by interposing the animal between the sources of x rays and the sensitive film (direct radiography), or the animal may be placed between the x-ray source and a fluorescent screen which may then be recorded by indirect cineradiography. In vascular anatomy Thorotrast is of value in the study of capillary networks where its use is usually combined with micro-arteriography. In lower vertebrates, phagocytic activity is not so markedly confined to liver and spleen as it is in mammals, and thus injection of Thorotrast by a suitable route enables sites of phagocytosis and accumulation to be detected. Examples are shown where Thorotrast was injected into the dorsal lymph sac of the frog and was then seen, after circulating in the blood stream, to have accumulated in certain organs. If radiographs are taken of the various organs, intense shadows are found in the liver, in the spleen, and also in blood vessels, as in those of the wall of the alimentary canal and, to a lesser degree, in the lungs. The skin is devoid of any accumulation. After the Thorotrast has been located by radiography in this way, the organs may be sectioned and Thorotrast detected microscopically. Additional proof that particles in tissue sections are the injected Thorotrast can be obtained, by making use of the fact that Thorotrast, being slightly radioactive, allows autoradiography to be conducted. The exposure time is long, usually weeks, but after this time tracks of α particles can be seen. An illustration of this technique is provided which shows the tracks of α particles emitted by Thorotrast accumulated in liver cells of a frog. (TCO)

36183 ON MALIGNIZATION OF BENIGN TUMORS AND FIBROUS OSTEODYSTROPHIA FOLLOWING X-RAY THERAPY. Dunaeva, L. A. Med. Radiol., 10: No. 5, 30-5(May 1965). (In Russian)

Literature on the blastomogenic effects of x rays on bone is reviewed, and clinical observations of sarcoma development following radiotherapy for exchondroma, giant-cell tumors or bone cysts are presented. The expediency of using intensive x irradiation for treating giant-cell bone tumors is presented. (H.G.D.)

36184 DETERMINATION OF THE RADIATION DOSE IN THE LIVER OF PATIENTS WITH POLYCYTHEMIA BY MEANS OF BREMSSTRAHLUNG RADIATION DURING RADIOPHOSPHORUS TREATMENT. Lapchenkov, V. I. (Lab. of Isotopic Tracer Studies and Central Scientific-Research Inst. of Reontgen-Radiology, Leningrad). Med. Radiol., 10: No. 5, 51-5(May 1965). (In Russian)

A method for determining radiation dose in patients treated with radiophosphorus for polycythemia is described. The quantitative relationship between liver dose and quantity of radioisotope per unit of body weight was derived from statistical data on 20 patients. (H.G.D.)

36185 PROBLEMS OF PROTECTION AGAINST β-PARTICLE BREMSSTRAHLUNG OF SOME ISOTOPES USED IN MEDICINE. Eliseev, V. S.; Korenkov, I. P.; Golikov, V. Ya. Med. Radiol., 10: No. 5, 75-8(May 1965). (In Russian)

Bremsstrahlung spectra are described for various beta sources used in medicine. To protect against damage from beta bremsstrahlung it is suggested that: absorbed doses be calculated and that protective measures be planned in view of the absorbed dose; screens used to separate the patient and the source be of low atomic number; and shielding materials other than lead-impregnated rubber or glass be used. (H.G.D.)

36186 THE DOSE DISTRIBUTION IN ROTATION-CONVERGENT IRRADIATION. Bibergal, A. V.; Ratner, T. G.; Lipis, V. L. Med. Radiol., 10: No. 5, 78-81(May 1965). (In Russian)

The influence of the depth of the rotation center, size of the irradiation field, and the use of counter-fields on distribution in the rotation-convergent mode of irradiation was studied. For some cases variations in dose distributions created by different methods of irradiation. The rotation-convergent method yields a number of advantages; the authors show the possibility of widening the field of its use on superficial foci. (auth)

36187 A COMPARATIVE ASSESSMENT OF SOME METHODS OF PREOPERATIVE X-RAY THERAPY OF MILK-DUCT CARCINOMA. Lindenbraten, L. D.; Priev, I. G. (Inst. of Hematology and Blood Transfusion, Moscow). Med. Radiol., 10: No. 6, 28-34(June 1965). (In Russian)

The results of combined treatment in 126 patients suffering from milk-duct carcinoma were investigated. In 40 patients preoperative x-ray therapy was instituted according to the instruction of the Public Health Ministry; in 60 with the aid of stage-by-stage irradiation of the primary focus and lymphatic tract and nodes of the 1, 2 and 3 order; and in 29 patients according to the technique of accelerated irradiation (for a period of 8 days) with a subsequent early operation. The incidence of relapses and metastases was in relation to the stage of the disease and did not depend on the technique of preoperative irradiation. The general and local radiation reactions were most marked when the accelerated method of treatment was employed. This technique is inexpedient in the routine method of orthovolt radiotherapy. The necessity for elaborating new effective techniques of preoperative Ra therapy, that would ensure a more rational distribution of the radiation energy in the organism of patients, is emphasized. (auth)

36188 REDUCTION OF THE IRRADIATION DOSE TO LUNGS IN STUDIES MADE IN CHILDREN. Simon, K. (Fachkrankenhaus fuer Atmungsorgane, Aprath, Ger.). Monatsschr. Kinderheilk., 111: 356-7(Sept. 1963). (In German)

A device is described that consists of a stage on which a child to be x rayed stands. The stage is motor driven so that the child's chest can be brought into position against a cassette that conforms to the size and breadth of the chest. Three sizes of cassettes are made available; 18 × 24 cm, 24 × 30 cm, and 35 × 35 cm. Since the best exposures are obtained if the child is held in position by an adult, the stand is outfitted with Pb shielding and the medical assistant can be protected further by Pb lined gloves. The x-ray beam is focussed as closely as possible to the dimensions of the cassette opening used. Exposure times of 0.75 sec seem to be most suitable, according to the ability of a child to hold his breath and the requirement for an adequate exposure. For fluoroscopic examinations a 9-in unit is very satisfactory, permitting sharp contrast, easy evaluation, and reduction in the irradiation dose. This size permits the entire thorax of a 3-yr-old child to be viewed at one time, and is satisfactory for viewing the thorax in older children, section by section. Often this type of equipment may make it unnecessary to make x-ray photographs. (BBB)

36189 POSTRADIATION COMPLICATIONS FOLLOWING THE TREATMENT OF CARCINOMA OF THE UTERINE CERVIX IN THE MATERIAL OF THE INSTITUTE OF ONCOLOGY AT GLIWICE IN THE YEARS 1953-1955. Kozlik, Ryszard; Wieckowska, Zofia; Czaplewski, Stanislaw. Nowotwory, 15: 51-7(Jan.-Mar. 1965). (In Polish)

In the years 1953–1955 1943 patients with carcinoma of the uterine cervix received radiation treatment in the Institute of Oncology of Gliwice. In 665 cases early complications appeared following the treatment including 100 serious complications and in 175 cases late complications were present. The percentage of serious complications (5.1%) and of fatal cases (1.1%) was one half lower than in the years 1947–1952 (10% and 2.8%). In comparison with preceding years the percentage of late complications was also lower, among which only the fracture of the neck of femur occurred more frequently. At the same time the percentage of early minor complications, mainly of the rectal or of urinary blader reactions, increased. These differences are statistically significant. (auth)

36190 OWN EXPERIENCES IN THE TREATMENT OF THE CARCINOMA OF THE UTERINE CERVIX WITH MANCHESTER METHOD. Hliniakowa, Irena. Nowotwory, 15: 59-64(Jan.-Mar. 1965). (In Polish)

Detailed analysis of results of treatment of 40 patients with cancer of the uterine cervix in the first stage treated according to modified Manchester method is presented. Postradiation complications and number of faulty applications confirmed radiologically or by measurement are discussed. The rationale of introducing this method as routine procedure in the Institute of Oncology at Gliwice is also discussed. The rate of 3 years cure was 75% and of 5 years cure 65% and no significant differences were noted in comparison with previous results. Postradiation reactions particularly in rectum and bladder were common but fatal complications or those requiring surgical intervention were absent. The exposition of radiologist and nursing staff to radiation was lower as compared with the previously applied method. The duration of treatment in stage 1 of advancement of the disease was shorter, by 5–6 weeks. Introduction of physical methods of measurement of the dose of radiation increases the precision of treatment, is a foundation of further development of the method, and allows its reproduction. (auth)

36191 DISTRIBUTION OF DOSES IN POINTS SCREENED BY BONE IN THE THERAPY WITH X-RAYS GENERATED IN THE ROENTGEN TUBE OF 200 kv PEAK TENSION. Lobodziec, Wlodzimierz. Nowotwory, 15: 93-6(Jan.-Mar. 1965). (In Polish)

The absorption of x rays with HVL 1.5 Cu in a_1 bone situated in water medium and the influence of bone on the distribution of a_1 dose in points below bone at greater distance than the range of secondary electrons generated during absorption of x radiation in bone were investigated. Results of experiments are tabulated. (auth)

36192 THEORY OF RADIATION THERAPY OF PROLIFERATIVE DISEASES OF THE HEMATOPOIETIC SYSTEM. Bandres, Julio Rivera (Provincial Hospital, Madrid). Nucl. Energy, 181-9(June 1965).

The mechanisms by which ionizing radiation acts on cells of the hematopoietic system at the molecular level, at the microstructural level, and at the tissue level are reviewed. The radiotherapy of proliferative diseases of the hematopoietic system is discussed with emphasis on leukemias and polycythemia. The importance of the total radiation dose and dose fractionation are emphasized. Applications of ^{32}P in the treatment of hematopoietic diseases are discussed briefly. (64 references) (C.H.)

36193 SHIELDING DESIGN FOR COBALT-60 TELETHERAPY INSTALLATIONS. Braestrup, Carl B. (Francis Delafield Hospital, New York). Nucl. Struct. Eng., 2: 134-41(July 1965).

Principles of radiation shielding design for ^{60}Co teletherapy installations are discussed. The requirements for radiation protection are outlined, and the influences of

general layout and operational aspects on the design of the shielding for teletherapy rooms are indicated. Shielding design examples are given. (auth)

36194 DOSIMETRY OF SELENOMETHIONINE Se^{75} FOR PANCREATIC SCANNING. Sodee, D. Bruce; Renerts, Lea; Hill, Glenn; Distefano, Berardino (Doctors Hospital, Cleveland Heights, Ohio). Nucleonics, 23: No. 7, 78-81(July 1965).

The distribution of selenomethionine-^{75}Se in the organs of dogs is discussed, and some pertinent points about its use for pancreatic scanning are given. Included are an autoradiograph and photoscan of a dog pancreas, and charts showing concentrations and effects. (J.F.P.)

36195 EXPERIMENTS ON THE USE OF A CADMIUM SULFIDE MONITOR IN HIGH ENERGY DOSIMETRY. Del Vescovo, A. V.; Scalia, R. (Universita, Rome). Nuntius Radiol., 30: 1078-85(Nov. 1964). (In Italian)

Some dosimetric studies were carried out on a ^{60}Co unit by means of an apparatus utilizing cadmium sulfide. It was concluded that cadmium sulfide can be used as a dosimeter of precision for the measurement in high energies. Advantages of the dosimeter described are discussed. It was not influenced by temperature, humidity, or atmospheric pressure. It is simple to use. For the intracavitary dosimetry with immediate reading, this dosimeter has many advantages in relation to both its size and the safety of the patient. (auth)

36196 ROUTINE USE OF ISOTOPE LOCALIZATION OF THE PLACENTA USING ^{131}I. Merchant, R. J.; Moran, J. P. (U. S. Naval Hospital, San Diego, Calif.). Obstet. Gynecol., 23: 72-5(Jan. 1964).

The use of ^{131}I-labeled serum albumin (RISA) for localization of the placenta in 255 patients is reported, with data included on its radiologic safety, advantages over other methods, and clinical results. The amount of radiation exposure resulting from 5 μC of intravenous RISA is less than 5% of the Atomic Energy Commission's recommended max dose. The principal route of excretion of ^{131}I is via the urine, with 60% being excreted within the first 48 hr. The normal rate of iodine uptake by the thyroid gland averages 2 to 4%/hr of the unbound iodine in the blood. With isotope localization of the placenta, the fetus received an estimated 25 mR, which is $^1/_{10}$ to $^1/_{20}$ of that received with two radiographic placentography exposures. Thus the safety of fetus and mother is assured. Since administration of an iodine solution will markedly decrease the radiation delivered to the thyroid gland, all patients were given 10 drops of saturated solution of potassium iodide orally in order to block the fetal and maternal thyroids from further uptake of ^{131}I. This dose was continued 3 times per day for 5 days. Five μC of ^{131}I serum albumin, which is as effective as the 10 μC originally used, was injected intravenously. After allowing 10 min, for thorough vascular mixing of the tracer substance, a scintillation detector with a scaler was placed over the xiphoid which is used as a reference point because of its proximity to the vascular pool in the heart and liver. (TCO)

36197 CURRENT ORAL SURGICAL OPINION CONCERNING THE VALUE OF PREIRRADIATION EXODONTIA. Degnan, Edward J. (Veterans Administration Hospital, Albany). Oral Surg. Oral Med., Oral Pathol., 18: 307-11 (Sept. 1964).

An attempt was made to poll 100 prominent oral surgeons for their opinions concerning the value of preirradiation exodontia in reducing the incidence of osteoradionecrosis. Among those in favor of oral surgery, there was a substantial lack of agreement concerning the extent of surgery deemed necessary or length of time to allow for healing prior to the start of x-ray therapy. To the question: "Do you believe that exodontia (full-mouth, those in the line of radiation therapy, or those grossly carious) significantly reduces the incidence of radionecrosis of the maxilla or mandible?", 54% answered, "Yes." To the second question: "If answer to the first question is "yes," what is the minimum time allowed for the healing process prior to the initiation of radiation therapy?", the median answer (22%) was "seven to ten days." Some comments received are reported as illustrating the markedly divergent opinions. Most of those responding to the poll favored pre-irradiation exodontia without any equivocation. Some believe such exodontia to be essential from observing cases of severe necrosis resulting from extractions performed as much as four years after irradiation. Most surgeons believe in delaying radiation treatment until there is complete healing of the wound. Many prefer to delay therapy for 10 days and state the common feeling of oral surgeons that the radiotherapist starts his treatment too soon after exodontia. (TCO)

36198 FLUOROSCOPIC AND POLAROID CONTROL OF HYPOPHYSIS DESTRUCTION. Strandjord, Nels M.; Harper, Paul V. Jr. (Univ. of Chicago, Ill.). Postgrad. Med., 35: A69-72(Aug. 1964).

A new approach to the radiation destruction of the hypophysis utilizes a ^{90}Sr needle. In this needle the ^{90}Sr (54 mC) with a half life of 28 yr is in equilibrium with its daughter ^{90}Y, giving an almost permanent source of ^{90}Y, an excellent source of β radiation. A 60- to 90-min application of this source in the right and a similar application in the left side of the hypophysis produce adequate destruction of the gland. The new method uses film control for localization relative to the midline. The Polaroid Experimental TLX Radiographic Packet (which has five times the speed of conventional x-ray film with double screens and can be developed in the operating room without darkroom facilities in less than 1 min) permitted accurate, rapid localization. The elimination of fluoroscopy in one plane also reduced the radiation dose to the surgeon, anesthetist, and radiologist. The operative procedure and the instruments are described. The head holder, image intensifier, and overhead x-ray tube with the cassette tunnel under the head holder are illustrated. The image intensified fluoroscope is sharply coned to reduce x-ray exposure to personnel. Final position of the radioactive source is checked by Polaroid films. Thus, destruction of the hypophysis with a $^{90}Sr-^{90}Y$ needle reduced the incidence of cerebrospinal fluid leakage by half and the incidence of extraocular nerve damage to zero. The use of rapid-processed Polaroid film for x-ray control greatly reduced operative time, and the better localization of the radioactive source by film control helped reduce extraocular nerve damage. The procedure is simple and does not require elaborate equipment. (TCO)

36199 SIMPLE MASTECTOMY PLUS POSTOPERATIVE IRRADIATION BY THE METHOD OF McWHIRTER FOR MAMMARY CARCINOMA. Kaae, Sigvard; Johansen, Helge (Univ. of Arahus, Denmark). Progr. Clin. Cancer, 1: 453-61(1965).

Clinical results, complications, and dose factors in the treatment of 331 patients with breast cancer by the McWhirter method are presented. The method consists of simple mastectomy followed by heavy x ray therapy. At surgery, excessive skin should not be removed, for tension on the skin flaps may be associated with failure of the wound to heal and delay in the application of radiotherapy. Tightly stretched skin flaps do not tolerate radiation well. Skin grafting does not overcome the difficulty, for grafts do not tolerate x-ray treatment either. The postoperative x-ray treatment should be started as soon as possible after the operation, usually in two weeks. Four fields are used, and every field is treated every day. It was administered by a conventional x-ray unit with a half-value layer of 3 to 3.35 mm of Cu, and the max dose was 4500 R, in 3 weeks. There was a 5-year survival rate of 55% in the McWhirter group and 56% in the extended radical mastectomy (no radiation) group, and a 5-year recurrence-free survival in 45% and 42% respectively. Originally, the max skin dose was about 4500 R in three weeks, but as the skin reaction to this dose was fairly severe, the max skin dose was reduced to about 4300 R. Thereafter, the skin reaction was dry with only occasionally a minor moist reaction in the axilla or an-

terior to the anterior axillary fold. After treatment by McWhirter's method, chest radiography often showed pneumonitis in the upper part of the lung on the irradiated side. As a rule, it subsided without leaving radiologically demonstrable fibrosis or only a trace of such fibrosis. There were no subjective complaints on account of pneumonitis or pulmonary fibrosis. X ray examination in several cases disclosed spontaneous rib fractures, most often anterolaterally in the second or third rib, which healed with callus formation. These radiation fractures did not give rise to subjective complaints; presumably, they might have been avoided by using megavolt radiation. One patient showed pronounced radiation fibrosis in the axilla with greatly restricted mobility in the shoulder; in error she received the maximum skin dose of about 5200 R. There were no other cases of major fibrosis in the soft tissues, nor any difficulty in obtaining a free range of movement in the shoulder joint. Edema and weakness of the arm on the operated side were more common following extended radical masectomy than the McWhirter method. (BBB)

36200 NEWER TECHNIQUES IN TREATING LYMPHOSARCOMA. Molander, David W. (Cornell Univ., New York). Progr. Clin. Cancer, 1: 664-82(1965).

Use of radiotherapy (primarily 250-kv x rays) to treat various forms and stages of lymphosarcoma is described, with attention to doses, field planning, normal tissue tolerance in various sites, and complications and their treatment. Radiation therapy has been most beneficial in treating ulcerative skin lesions with extension to the underlying nodes. Primary and secondary lymphosarcoma of the eye and orbit was treated by employing a direct cone attached to a 250-kv x-ray machine giving 2400 R in air, using increments of 200 to 250 R daily. Cataracts have not developed following this therapy, although if the patients live long enough, this might occur. Mediastinal involvement is treated by irradiation through anterior and posterior ports with 250 to 300 R given daily to alternate ports. In place of orthovoltage x-ray therapy, supervoltage x rays, ^{60}Co, or the betatron may be employed; otherwise, for a tumor as radiosensitive as lymphosarcoma, orthovoltage therapy has proven quite satisfactory. If pleural infiltrates are suspected, the involved lung area is given, with anterior and posterior ports, 2500 to 3000 R to each port. Intracavitary or local injection of radioisotopes, such as ^{32}P and ^{90}Y may be used in special settings with beneficial results. Radiation fibrosis may occur following 2500 to 3000 R to the lung. The stagnation of secretions with superimposed infection with the loss of the normal elasticity presents a special problem. There is no cure for radiation fibrosis. Treatment of the bronchial tree with an expectorant cough mixture, steam inhalations, potassium iodide, and postural drainage, together with inhalations of surface tension-reducing agents such as Alevaire, are helpful. Occasionally steriods may make these patients more comfortable. The diminished vital capacity may be disabling, and mediastinal retraction toward the side of the fibrosis may add to the discomfort. A broad radiographic shadow simulating residual lymphosarcoma may be present, and additional radiation therapy must be avoided. Treatment plans for lymphosarcoma of the gastrointestinal tract are presented. Radiation necrosis may follow repeated courses of intensive treatment to the same region, for example, the pelvis or femur. In such instances, lower successive doses, such as 1500 to 1800 R total dose, are given. Treatment of central nervous system lymphosarcoma is also considered. As the disease progresses and becomes more generalized, and with repeated courses of therapy, resistance develops to treatment by the three common modalities: irradiation, alkylating agents, and steroids. There is no cross-resistance, but with prolonged growth activity, an increased resistance may be expected sooner or later. (BBB)

36201 THE POSITION OF RADIATION THERAPY OF TUMORS IN MEDICINE. Rode, I. (Orszagos Onkologiai Intezet, Budapest). Radiobiol. Radiotherap., 6: 303-7 (1965). (In German)

Radiotherapy in the field of basic research is connected with medical physics and biology. It is furthermore connected with surgery and the manual medical branches, by clinical relations and with internal medicine. The extensive cooperation of radiotherapy with clinical branches led to the wrong opinion that it had a secondary role. In order to revise this opinion, it is necessary to emphasize the mechanism of radiation effects that differentiate radiotherapy from any other therapy and the success achieved with different tumors using radiotherapy alone. (H.G.D.)

36202 CONTRIBUTION TO HALF-VALUE TISSUE DEPTH. Brauer, W.; Tautz, M. (Staedtische Klinikum, Berlin). Radiobiol. Radiotherap., 6: 361-6(1965). (In German)

Half-value tissue depth measurements in skin samples and in paraffin phantoms were compared. Skin samples were taken from the calf of a single subject. Variations in dose absorption were greater in the phantom material. It was confirmed that use of phantoms in dermatological radiotherapy results in incorrect dosimetry, and suggested that skin standards replace the phantom materials accepted internationally for dosimetry. (H.G.D.)

36203 SUPERVOLTAGE AND CONVENTIONAL THERAPY. WHICH AND WHY? A TECHNICAL APPRAISAL. Green, Miles F. (Inst. of Radiotherapy, Perth, Australia). Radiography, 10: 6-9(Sept. 1963).

Various aspects of the use of linear accelerators in tumor radiotherapy are discussed and isodose patterns are provided. (BBB)

36204 PAEDIATRIC RADIOLOGY. Franklyn, P. P. Radiography, 30: 243-51(Oct. 1964).

Protection is of paramount importance to children, as growing tissues are more sensitive to irradiation and large areas may be irradiated if care is not taken. No radiological investigation should be undertaken without good clinical indication. Elaborate techniques should be simplified as much as possible, fluoroscopy reduced, and unnecessary repetition avoided. For instance, opaque foreign bodies in the alimentary tract should only be checked at five-day intervals unless there are signs or symptoms of complications; generally they will have been passed before a second examination is made. Gonad shields should be used whenever possible and in some cases the use of armadillo pants may be useful. (BBB)

36205 ON THE SIMPLE APPARATUS FOR PHOTOSCANS. Yasukochi, Hiroshi (Tokyo Univ.). Radioisotopes (Tokyo), 14: 233-8(May 1965).

A simple way to obtain photoscintigrams is reported. This apparatus is economically superior to others. The brightness of the lamp (argon) was decreased by an absorption filter made of a plastic plate until the film density developed could not be observed by one pulse or by an accumulation of a few pulses. By this way the density of the film can be observed when the accumulation of pulses becomes greater. The lens and slit are omitted to make a wide round spot. A scatterer is used to weaken the light and make it uniform. Example photoscans are shown. (TCO)

36206 THE ORBITRON, A UNIVERSAL DEPTH THERAPY UNIT WITH COBALT-60. Schanze, Ulrich O. Radiol. Austriaca, 14: 221-9(1963). (In German)

The orbitron is a rotating irradiation apparatus that uses up to 2000 C of ^{60}Co as an irradiation source, with a dose rate of 60 R/min, measured at 75 cm from the surface of the irradiation head. At 60 cm the dose rate is 90 R/min. The shield, mounted on the irradiator housing, permits effective irradiation up to a distance of 75 cm. At this distance the window limits the beam to a maximum of 30-cm dia, with a minimum size of 2 cm possible. The construction of the orbitron permits the size and cost of the protective irradiation barrier to be reduced. The irradiation head is mounted on a motor-

driven rotating rim about an axis of 65 to 75 cm. It is stabilized, and has speeds that can be varied between $\frac{1}{8}$ and $\frac{1}{2}$ rpm. An optional velocity of 1 rpm can be obtained. The irradiation head is suspended at 48 cm from the rim, and can be moved a total of 150° from the horizontal axis. The author briefly describes many other of the mechanical features of this specialized instrument, which is very suitable for pendulum and rotational irradiation. In addition, other characteristics of the orbitron are shown by isodose curves obtained with a 2000-C source, and a focal distance of 65 cm. (BBB)

36207 RADIOACTIVE ISOTOPES IN NEUROLOGICAL DIAGNOSIS. II. FURTHER USES OF RADIOACTIVE ISOTOPES IN NEUROLOGY. Ortiz Berrocal, J. (Rudolf Virchow Krankenhaus, Berlin). Rev. Clin. Espan., 91: 333-40(Dec. 31, 1963). (In Spanish)

The use of numerous radioisotopes in diagnosis of neurologic disorders is described, by reference to 77 publications, with emphasis on kinetics of isotope clearance, doses used, radiation exposure of the patient, and techniques for detecting the isotopes. Spinal cord tumors can be localized by injection of 100 to 200 μC of ^{131}I-labeled serum albumin (RISA) into the lumbar spinal cord subarachnoid space. Gamma scintigraphy will detect blockage of the subarachnoid space or increased vascularity due to tumors. Injection of 5 to 15 μC of ^{133}Xe into the spinal canal can also be used to detect metastases or primary spinal cord tumors. Both of these are innocuous procedures, and carried out with precise results in 100 out of 100 cases tested. Study of the circulation of cerebrospinal fluid can be carried out with ^{24}Na injected intravenously in a dose of 400 μC. This isotope has a convenient half life (15 hr) and emits β (1.39-Mev) and γ (1.368- and 2.754-Mev) radiation. An increased level of ^{24}Na is found in cerebrospinal fluid in various types of meningitis. Also, intrathecal injection of ^{24}Na, ^{32}P, or ^{131}I, followed by blood measurements, can be used to detect spinal cord lesions. Diagnosis of abnormalities in the cerebral ventricles with the aid of ^{32}P, ^{42}K, ^{76}As, and ^{82}Br is also described. Subarachnoid hemorrhage can be detected with ^{24}Na. Kinetic consideration of study of the cerebral circulation with radioisotopes is outlined. In the method employing inhalation of 500 μC of ^{133}Xe, the patient receives a radiation of about 3 mrep to the tracheal mucosa and 0.3 mrep to the gonads and bone marrow. In the older method using 1 to 1.5 mC of ^{51}Cr-labeled red cells to measure cerebral circulation time, the whole-body dose is about 0.1 rad. (BBB)

36208 ACTINIC COMPLICATION OF TREATMENT OF CANCER OF THE CERVIX. Papucci Herrera, Santiago; Navarine, Hugo; Masi, Cayetano; Cerro, Emilio (Catedra de Clinica Ginecologica, Rosario, Arg.). Semana Med. Buenos Aires, 122: 1452-3(June 17, 1963). (In Spanish)

Injuries following pelvic irradiation for gynecologic cancer are discussed, and experiences with complications developing in 146 cases of cervical cancer are related. Complications developed in 24 of the patients as a result of combined Ra-^{60}Co radiation treatment and in 56 others from combined Ra and x-ray therapy. The principal complications took the form of rectal and bladder injuries, ureteral stenosis, and radiation sickness. Spontaneous fracture of the neck of the femur and subcutaneous connective tissue fibrosis were not problems in this series, unlike earlier series. The rectal lesions (occurring 4 to 12 cm from the anus) and bladder injury could be ascribed to the high total dose and its fractionation period and to the initial state of the tissues. These two types of injury frequently occurred in the same patient, 80% of those with cystitis and 71% of those with rectitis showing both complications. Data on the occurrence of various grades of severity of these lesions in each of the four stages of cervical cancer are tabulated. Most complications were noted in stage I cancer; this stage accounted for 31% and 46% of the total cases of cystitis and rectitis, respectively. Ureteral stenosis was most frequently caused by compression by the carcinoma, but also by postirradiation fibrosis. Radiation sickness was seen in six cases (4.1%), and in three cases was so severe that treatment was stopped. Mortality as a result of treatment in this series was 0.6%. Radiation injuries can be minimized by: an exhaustive clinical examination of the patient; adaptation of the therapy to the individual patient; radiologic studies to outline the field to be irradiated; and a plan of irradiation that will protect healthy structures. (BBB)

36209 VAGINAL FISTULAS FOLLOWING RADIOTHERAPY. Graham, John B. (Roswell Park Memorial Inst., Buffalo). Surg. Gynecol. Obstet., 120: 1019-30 (May 1965).

Most radiation fistulas are associated with cancer of the cervix and a few follow treatment of other pelvic cancers. The frequency of fistulas in irradiated cervical cancer ranges from 1 to 10% depending on several factors, including the proficiency of the therapist and extent of the cancer. The total number of such fistulas is estimated to be about 400 annually in the United States. Most radiation fistulas occur within the first two years of treatment. Their frequency then declines progressively, but they have been reported to occur as late as 26 yr after treatment. Fistulas which occur during radiotherapy are usually due to dissolution of tumor that penetrated the wall of both vagina and bladder or rectum. These are regarded as unavoidable. Almost all fistulas that occur after treatment is completed are due to too much radiation. The tissue damaging dose is usually higher than the tumor control dose and, although they tend to vary in the same direction in an individual patient, they overlap in different patients. Accordingly, a dose that may be too small to control the cancer in one will produce a radiation fistula in another. Patients with large, extensive tumors tolerate larger doses of radiation and their tumors require larger doses. The dose should be reduced in patients with small tumors and those who are old or thin. Their tumors require less radiation for control and they are more vulnerable to normal tissue damage. Another cause of damage is the injudicious distribution of the radiation; for example, a vaginal radium applicator lying against the rectovaginal septum is much more likely to result in a fistula than one packed away with gauze. An acute angle between the intrauterine tandem and the vaginal applicator, especially if the latter is located in the anterior fornix, may cause bladder injury. Surgical techniques are described in the muscle repair of fistulas performed in 23 patients. A summary of their histories is presented. There were nine patients with rectovaginal, five with vesicovaginal, and nine with double fistulas. They occurred during radiotherapy and at varying intervals up to 23 years later. All patients with rectovaginal fistulas underwent a preliminary colostomy. Of those with vesicovaginal fistulas, five were subjected to urinary diversion prior to repair of the fistula. The ureters were anastomosed to a short segment of ileum with a stoma in the hypogastrium on the right side. In the 23 patients there were two deaths and three other failures. Some improvements in surgical technic in repairing fistulas are outlined. Rectovaginal and vesicovaginal fistulas produced by radiation are difficult to cure surgically because of the poor healing properties of the tissues. Vigorous supportive care of the patient, atraumatic handling of tissue, good exposure through a Schuchardt incision, and the introduction of a pedicle muscle flap will restore normal function in most patients. (BBB)

36210 URETERAL STENOSES AFTER SURGICAL AND X-RAY TREATMENT OF COLLUM CARCINOMA. Jurukow, Krum Stefanow (Gynecological Clinic of the Oncological Research Inst., Sofia-Darvenitza, Bulgaria). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe, 12: 87(1963). (In German)

Several patients that had been irradiated for treatment of collum carcinoma subsequently developed ureteral stenoses, vesicovaginal fistulas, or infiltration of the bladder after recurrence of the tumor. In some of these patients the ureters were surgically implanted in the colon. In others nephrostomies were performed because of uremia induced by ureteral stenoses. Very often patients who had been successfully treated for their car-

cinoma died of complications that resulted from ureteral stenoses, because many times these were not diagnosed until a very advanced stage or not at all. Two general precepts should be followed. One of these is to avoid ureteral stenoses by improvement of the surgical procedures used. The second is to develop methods for early diagnosis of ureteral stenoses, so that when they do occur the consequences resulting from urinary obstruction will be avoided. (BBB)

36211 ON THE TREATMENT OF URETERAL AND BLADDER INJURIES AFTER GYNECOLOGICAL PROCEDURES AND AFTER X IRRADIATIONS. Heise, G. W. (Urologische Klinik der Medizinischen Akademie, Magdeburg, Ger.). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe, 12: 127-31(1963). (In German)

Postirradiation complications after treatment of gynecologic carcinomas occur more frequently in the ureters than in the bladder. Surgery performed on the uterus and its vicinity shows primary injuries to the inferior portions of the ureters. The chief reason for this is the close relation of the ureters to the arteria uterina, which cannot always be kept free of invasive growth. This is true particularly if the arteria uterina had been injured previously and required repair. Secondary changes also may occur during the post-treatment period in the lower ureteral areas and bladder, especially with depth radiotherapy. These changes consist of scarification and closure of the ureteral lumen, with marked ureterectasis, pyelectasis, and kidney blockage. Irradiation of the bladder may cause sclerosis, fibrotic changes, and bladder shrinkage to 100 ml capacity or less. In recent yr many of these changes induced by irradiation have been observed after depth therapy. (BBB)

36212 ON THE TREATMENT OF IRRADIATION CYSTITIS. Ruskova-Christova, Swetlana; Andreev, F. (Urological Clinic of the Inst. for Medical Training and Education, Sofia, Bulgaria). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe, 12: 133(1963). (In German)

Three forms of irradiation cystitis have been observed. The acute form developed soon after x irradiation with 10000 R following total hysterectomy. The bladder mucosa was diffusely reddened and swollen. For treatment, urinary tract antiseptics and presacral Novocaine blockade were sufficient. The proliferative, chronic type of cystitis was observed from 3 to 5 yr after treatment with 12000 to 17000 R of x irradiation or 10000 to 20000 R of x irradiation in combination with 7200 to 9000 mg-hr of Ra irradiation. It gave the appearance of a hemangioma-like tumor on the floor of the bladder. The area was hyperemic and appeared to be papular. The tissue was not malignant. For treatment, electrocoagulation and urinary antiseptics were used. The third type of cystitis observed was necrotic. It was observed after total hysterectomy with massive doses of x irradiation and Ra treatment. It was characterized by development of vesicovaginal and rectovaginal fistulas. These were repaired surgically. (BBB)

36213 ON THE TREATMENT OF FISTULAS OCCURRING AFTER RADIOTHERAPY. Dzieszko, Waclaw (Women's Clinic of the Medical Academy, Bialystok, Poland). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe, 12: 143-4(1963). (In German)

The author discusses the fistulas that occur after irradiation treatment of uterine cancer, which he studied by cystoscopy and cystometry. Fistulas which are not caused by irradiation can be corrected very frequently. Only a few of these fail to heal. However, it is difficult to correct the fistulas that appear after irradiation, and usually these must be treated symptomatically. There is no particular surgical approach that is best suited to this treatment, and many plastic surgical techniques must be used. Among the corrective procedures that can be used, depending on the particular case, are the methods of Doederlein, implantation of well-vascularized tissue from the tissue in the vicinity of the fistula, and use of estrogens. There is a definite need for improvement of the symptomatic treatment used in cases of postirradiation fistulas that will not heal. In severe cases it may be necessary to externalize the ureters by nephrostomy or transplantation to the colon. Basically, the most important type of damage that irradiation causes is damage to the blood vessels, or endoarteritis obliterans, which may lead to necrosis of the tissues. When this type of radionecrosis involves the ureters, bladder, etc., a postirradiation fistula may develop. (BBB)

36214 LOW ENERGY GAMMA EMITTERS IN SCANNING AND OTHER CLINICAL APPLICATIONS. Ross, D. A.; Harris, C. C.; Satterfield, M. M.; Bell, P. R.; Jordan, J. C. p.108-25 of Radioaktive Isotope in Klinik und Forschung. Band VI. Munich-Berlin, Urban and Schwarzenberg. 1965. (In German)

The low-energy γ emitters present several attractive characteristics for clinical uses. It is tempting to use them, for example, in order to minimize leakage through the partitions of a honeycomb collimator, or through the lateral walls of a large-bore collimator. Low-energy radiation has, however, an unfortunate habit that detracts from its value: Compton radiation scattered from a low-energy ray tends to be only slightly degraded in energy. For example, the chief ray emitted by cobalt-57 (122 kev) can in no case deliver more than a third of its energy to an electron, and thus the scattered energies are crowded into a narrow band lying between 83 and 122 kev. This makes it difficult for a pulse-height spectrometer to distinguish between the legitimate, primary radiation that originates within the collimator's field of vision, and the scattered radiation generated there by rays that come in from off-target sites. The system may therefore continue to see off-target structures in spite of the decreased leakage of the low-energy rays through the collimator's walls. Thus scans made with these emitters often show a haziness that resists conventional spectrometer treatment. Special, asymmetrical window settings can reduce large-angle scatter, but moderate- and small-angle scatter, involving as they do little energy loss, present the discriminating mechanism with an impossible task. This scattering problem requires careful consideration, lest it cancel out the gains offered by the increased collimator opacity. (auth)

36215 AQUEOUS RADIOPAQUE SOLUTIONS CONTAINING SODIUM AND CALCIUM IONS. Bird, Joseph G. (to Sterling Drug Inc.). U. S. Patent 3,175,952. Mar. 30, 1965. Filed May 29, 1963.

A composition for use in radiopaque diagnostic examination consists of an aqueous solution containing at least 10% by weight of the anion of an iodinated organic acid that is effective as an x-ray contrast agent and has a low intravenous toxicity effect. The cation content of the solution includes sodium and calcium such that the combined weight of the salts in the solution is at least 10% that of the entire solution, and the Na/Ca ratio by weight is between 5 and 75. (B.L.M.)

CHEMISTRY

General

36216 (BNL-900(p.29-72)) CHEMISTRY AND CHEMICAL ENGINEERING DIVISION. Dwyer, O. E.; Wiswall, R. H. (Brookhaven National Lab., Upton, N. Y.).

Equilibrium properties of a variety of inorganic systems at high temperatures were determined. Data were obtained as the free energies of formation of the trifluoride, triiodide, and dicarbide of U; the fluorides of Th, Al, Ni, Pb, and Co; and double chlorides in the systems KCl-$MgCl_2$, KCl-$CaCl_2$, KCl-$SrCl_2$, and KCl-$BaCl_2$. In another series of cells, molten-salt electrolytes were used; these gave information on energies of mixing in the systems LiCl-$SrCl_2$, NaCl-CsCl, and NaCl-RbCl. Chronopotentiometry was used to determine the solubility of Ag in AgCl; and spectroscopy was applied to the vapor of UI_3. The fluorocarbon analogs of biphenyl, naphthalene, o-terphenyl, and bicyclohexyl were exposed to $\approx 8 \times 10^7$ rads of gamma radiation. The most stable compound was F-biphenyl, which was markedly superior at 500°C to aromatic hydrocarbons. Exposure of Kr-F_2 mixtures, held at –140°C, to a beam of protons from the cyclotron resulted in the formation of KrF_2 in good yield. Equilibrium and kinetic measurements were made on the system, C-H-hydrocarbons at 2200 to 3000°K. The sublimation temperature of graphite was determined in various atmospheres, with results in good accord with theory. The synthesis of acetylene by the reaction of H_2 with C heated very rapidly to over 3300°K was investigated to find whether such a reaction would take place to a useful extent on C particles heated by the bombardment of fission fragments in fluidized-bed reactors. The internal structure of graphite was investigated by obtaining gas-adsorption surface areas on graphite samples after varying amounts of pulverization. The dissolution of enriched U-Zr alloy fuel is being examined on an engineering scale and the separation of U and Pu is being studied in laboratory experiments. Most of the recent process development work involves use of the system containing NOF. An increased effort is being directed toward the development of a fluidized bed process for recovering fissionable material from stainless steel- and Zircaloy-clad power reactor fuels. The addition of H_3PO_4 to waste and subsequent evaporation were found to produce a concentrated solution which is further reduced in volume and converted to glass upon being heated to 1200°C. During the year major effort was directed toward demonstration of the phosphate glass process, with simulated Purex-type waste. The release of fission products from reactor fuel materials is being studied to provide data for assessing the consequences of potential reactor accidents. The chemical states of I_2 released from metallic U and UO_2 into steam were studied. A study of forced-convection heat transfer with liquid metals includes single-phase and two-phase classes of heat transfer, both analytical and experimental. An experimental project to determine heat transfer coefficients for turbulent, in-line flow of NaK through an unbaffled rod bundle, consisting of 19 electrically heated ½-in.-OD rods spaced in an equilateral triangular array with a P/D ratio of 1.75 was completed. A project to obtain fundamental heat transfer information for use in the design of nuclear power plants for space vehicles using alkali metals as working fluids is described. A project to measure local heat transfer rates, coefficients, and pressure drops for K in a vertical, round-tube boiler is described. The experimental program on random beds resulted in the development of a precise technique capable of measuring small changes in solid fraction, a reasonable conservative test for stability, and a simple bed preparation procedure which yields satisfactorily stable beds. The SBFR potential for significant economic advantages over fixed fuel reactors due to reduced refueling time is being investigated. (J.R.D.)

36217 (IDO-14656) BURNUP DETERMINATION OF NUCLEAR FUELS: 1964 ANNUAL REPORT. Maeck, W. J; Rein, J. E. (eds.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). May 1965. Contract AT (10-1)-205. 48p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A status report is given of methods for the determination of burnup of nuclear fuels. The major analytical technique investigated is stable fission product analysis. The preparation of standard burnup and fission yield samples is presented. Chemical separations, the evaluation of several methods for stable fission product analysis, the preparation of standards for mass spectrometric analysis, and the dissolution of fuel samples are discussed. (auth)

36218 (LA–3235) THE TWO-DIMENSIONAL HYDRODYNAMIC HOT SPOT. VOLUME II. Mader, Charles L. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Nov. 20, 1964. Contract W-7405-eng-36. 127p. Dep. mn; CFSTI, $4.00 cy, $0.75 mn

The basic processes in the shock initiation of inhomogeneous explosives are investigated theoretically using the model of a cylinder of nitromethane containing either a cylindrical or a biconical void, or a sphere or cylinder of aluminum. The interaction of a shock with these density discontinuities, the resulting formation of a hot spot, and the buildup to propagating detonation are computed using two-dimensional numerical hydrodynamics of the PIC type. For the aluminum density discontinuities, the calculations exhibit failure or propagation of detonation from the hot spot in approximately the same manner as does the one-dimensional hydrodynamic hot spot model. The interaction of a shock with corners of aluminum and Plexiglas in nitromethane is discussed. Radiographs of a shock interacting with a spherical bubble in water are compared with theoretical calculations and confirm the validity of the computations. (auth)

36219 (LA-3249) EVALUATION OF HIGH EXPLOSIVE BY PYROLYSIS. Baytos, John F. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Dec. 1964. Contract W-7405-eng-36. 22p. Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

The thermal stability and compatibility of explosives and new explosive mixtures can be measured by detecting the evolved gases as an explosive is heated to decomposition. This technique is known as pyrolysis gas evolution analysis (PGEA). An apparatus was built that would enable one to perform these PGEA experiments on a routine basis as a complement to the other stability and compatibility tests. The apparatus is based on the prototype developed by R. N. Rogers and is described in detail. The various operating sequences are arranged for safety and ease of performance so that an operator's attention is given to gathering experimental data rather than to instrumentation. A detailed experimental procedure is given, and some preliminary experiments made to check the performance of this apparatus are described. Calibration procedures are also included. Preventive and corrective maintenance procedures are given. Illustrations and typical curves are also included. (auth)

36220 (MIT-2098-142) PROGRESS REPORT [ON PHYSICS AND CHEMISTRY]. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Nov. 1, 1964. Contract AT(30-1)-905. 151p. Dep.(mn); $5.00 (cy), 3(mn) CFSTI.

Research and development are reported on the chemistry of the fission elements, nuclear chemistry, and cosmic radiation. Experimental accelerator work is summarized along with research on radioactivity and energy levels, cyclotron experiments, and theoretical work on nuclear physics and elementary particles. (J.R.D.)

36221 METHOD FOR COLLECTING ZIRCONIUM TETRACHLORIDE. Gens, T. A. (to U. S. Atomic Energy Commission). U. S. Patent 3,202,475. Aug. 24, 1965.

A method of condensing gaseous zirconium tetrachloride comprises contacting the gas with the vapor in equilibrium over refluxing hydrochloric acid to form an aqueous solution of zirconyl chloride containing up to about 365 grams of Zr per liter. (AEC)

Analytical Procedures

See also Separation Processes and Procedures.

Refer also to abstracts 36724 and 36889.

36222 (AD-460411) DEVELOPMENT OF ANALYTICAL TECHNIQUES FOR THE DETERMINATION OF MINUTE QUANTITIES OF SELECTED ELEMENTS IN BERYLLIUM. Final Report, January 20, 1964–January 19, 1965. Henry, W. M. (Battelle Memorial Inst., Columbus, Ohio). Feb. 25, 1965. Contract NOw 64-0081-c. 65p.

A spark-source mass-spectrographic analytical procedure suitable for the determination of trace impurity elements in high-purity beryllium was developed. The mass-spectrographic-development work included (1) studies on the effectiveness of several sample cleaning techniques and sample "bake" treatments prior to the analysis; (2) the observation of residual gases given off during the bake and sample excitation cycles; (3) efforts to prepare low oxygen standards by use of ^{17}O additions to beryllium; (4) investigations on data readout procedures; and (5) application of the developed procedures to beryllium materials on which purity information was available. An emission-spectrographic method capable of determining many metallic impurity elements at or near the 1 part per million concentration level was developed, and a combustion-conductometric method was developed for the determination of carbon in the range of 1 to 10 parts per million with a blank variance of ±1 microgram in respect to the flux. Additional development efforts were directed toward the determination of carbon by combustion methods. These efforts–use of a gas-mass-spectrometric readout of evolved gases and the use of a very-high-frequency generator for fluxless sample combustion–show promise but need additional development. (auth)

36223 (AEET–207) ANALYSIS OF PLATINUM AND PLATINUM RHODIUM ALLOYS. Narasimham, N. A.; Kartha, V. B.; Saranathan, T. R.; Santhakumari, Kumari O.; Subramaniam, C. R.; Krishnan, T. S. (Atomic Energy Establishment, Trombay (India)). 1965. 15p. Dep. mn.

A spectrochemical method for the analysis of impurities in platinum and platinum–rhodium alloys is described. The platinum metal or the alloy is converted into the ammonium salt and then mixed with a zinc oxide–graphite buffer in the ratio 2:1. 15 mg of this mixture are burnt to completion in a d-c arc. The resulting spectra give the concentration of the impurity lines in terms of their spectral intensities. The method can be used in the concentration range of 10-200 ppm of the impurities with a standard deviation of less than ±15%. Rhodium is estimated by a spectrophotometric method after separation from platinum, using anion exchange resins. The accuracy of the rhodium estimation is better than 0.1% at the 5% concentration range. (auth)

36224 (AEET-211) NEUTRON ACTIVATION ANALYSIS OF TRACES OF URANIUM: SOLVENT EXTRACTION AND γ-RAY SPECTROMETRIC DETERMINATION OF Np^{239}. Alian, A.; Parthasarathy, R.; Sankar Das, M. (Atomic Energy Establishment, Trombay (India)). 1965. 20p. Dep. mn.

A neutron activation method is described for the determination of uranium in aluminum and lead. The (n,γ) reaction on ^{238}U is used indirectly by isolating and counting ^{239}Np formed by β decay of ^{239}U. Samples and standards are irradiated in the Canada India Reactor at a flux of 10 $^{13}n\text{-}cm^{-2}\text{-}sec^{-1}$ for about 3 days. The irradiated samples, after cooling for two days, are processed for the isolation of ^{239}Np. The chemical procedure consists in dissolving the sample and separating the ^{239}Np selectively by extraction with 2-thenoyl trifluoracetone. The extracted neptunium is stripped with 10 M nitric acid and an aliquot is counted for its γ activity. The overall recovery of neptunium was checked using ^{239}Np tracer and found to be quantitative under the experimental conditions. Hence, no corrections are required for chemical yield. The present method, while retaining satisfactory precision is simpler and quicker compared to most of the other methods reported in the literature. (auth)

36225 (AEET/Spec./8) THE ROTATING DISC ELECTRODE TECHNIQUE FOR THE SPECTROGRAPHIC DETERMINATION OF NIOBIUM, TANTALUM AND TITANIUM IN ORES. D'Silva, A. P.; Chandola, L. C. (Atomic Energy Establishment, Trombay (India). Spectroscopy Div.). 1964. 10p. Dep.(mn).

The rotating disc electrode technique was applied to the spectrographic analysis of niobium oxide (1–70%), tantalum oxide (2–30%), and titanium oxide (0.5–5%) in ores. The sample is converted into solution by fusion with potassium bisulphate and dissolution in oxalic acid. Molybdenum is added as an internal standard. The spectrum is recorded on a large quartz spectrograph by utilizing a spark source. Mo 2683.2 was selected as an internal standard for the analysis lines Nb 2950.9, Ta 2685.1, and Tl 3252.9. The standard deviation is found to be less than 5%. (auth)

36226 (APED–4662) MICRODETERMINATION OF FLUORIDE IN UO_2. Sabol, W. W.; Wills, W. F. Jr. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb. 15, 1965. 26p.

A method for determining microgram quantities of fluoride in uranium oxides is presented. The minimum detectable limit is 0.5 μg, and sample weights up to 200 mg can be used in the procedure. The standard deviation of a single measurement (expressed as percent recovery) varies from ±16% at the 1 μg level to ±1.6% at 10 μg. A microdiffusion method developed for determining the fluoride content in teeth has been modified and applied to the uranium system. Uranium dioxide is dissolved in 10% K_2CO_3–10% H_2O_2, placed in a Conway diffusion dish, acidified, and incubated at 60 ± 2°C for 22 hours. Fluoride is evolved as HF, which is collected in a caustic solution that is contained in a separate compartment of the covered dish. The quantity of fluoride is determined by its bleaching effect on the red Zr-SPADNS complex. It is necessary to destroy peroxide before diffusion, since it also bleaches the Zr-SPADNS complex. Interference from Al, Ce, La, Th, Ca, B, and Si in ratios to fluoride of 1000:1 is not observed; Zr interferes seriously at a 100:1 ratio. Advantages of this method are: 1) the extreme simplicity, 2) the sensitivity, which allows analysis of a very small sample, and 3) the ready adaptability to irradiated fuels, for which no easy method exists. (auth)

36227 (AWRE-O-22/65) A HELIUM GAS CHROMATOGRAPHY APPARATUS WITH HIGH VACUUM SAMPLING SYSTEM. Nash, J. R.; Sargent, T. (Atomic Weapons Research Establishment, Aldermaston (England)). June 1965. 20p. Dep.(mn); $0.80(BIS); 4s.(HMSO)

A helium gas chromatography apparatus is described for sampling small (0.1 cc) amounts of gas such as are extracted from metals. An ionization detector is used whose sensitivity can be adjusted to suit the composition of the gas. Very small aliquots of sample can be tested by the system described. Analyses of gas from blisters in fuel plates and gas extracted from zirconium hydride are given. (auth)

36228 (BNWL-SA–119) MULTIDIMENSIONAL γ RAY SPECTROMETRY AND ITS USE IN BIOLOGY. Nielsen, Julian M.; Kornberg, Harry A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [Mar. 24, 1965]. Contract AT(45-1)-1830. 14p. (CONF-650607-35) Dep. (mn); $1.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Recent developments in γ spectrometry have made possible the identification and measurement of a large group of

radionuclides in a complex mixture of radionuclides in a complex mixture of radionuclides with a single measurement on the sample. An instrumental technique is described for the determination of many radionuclides at trace levels in complex biological samples without the complication of chemical separation. The detector system consists of 2 anticoincidence shielded NaI(Tl) detectors, one of which has a pure NaI pipe that shields this crystal from γ radiation originating in its phototube; an amplifier for signals, and a 4096 channel analyzer with a photographic readout that permits a readout of the memory on 4 Polaroid prints in about 4 min. A paper tape perforator readout is used when data are to be analyzed by a computer. Operating procedures and characteristics of the detector assembly are described. Applications in environmental radionuclide measurements and in the study of trace elements in neutron-activated blood are reported. It is concluded that multidimensional γ spectrometry will find a wide range of applicability in biological studies. (C.H.)

36229 (BNWL-SA-137) SELECTIVE AND SENSITIVE ANALYSIS OF ACTIVATION PRODUCTS BY MULTIDIMENSIONAL γ RAY SPECTROMETRY. Perkins, R. W.; Robertson, D. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 5, 1965. Contract AT (45-1)-1830. 31p. (CONF-650405-5). Dep.(mn); $2.00 (cy), 1(mn) CFSTI.

From International Conference on Modern Trends in Activation Analysis, College Station, Tex.

γ-ray spectrometry detector systems were developed for use with multidimensional analyzers which permit an extremely sensitive and selective analysis of complex radionuclide mixtures. With these systems, use is made of the individual γ-ray decay characteristic of each radionuclide for identification and measurement. This is accomplished by sandwiching the sample between two detectors and canceling those events not totally absorbed in these detectors with a third annular detector which serves as an anticoincidence guard. The sample can be held in a fourth annular disc-shaped detector which allows the sample to be seen by the two principal detectors but which intercepts and cancels most of the degraded photons which would be scattered between them. The principal detectors are shielded from the γ-ray radiation originating in their phototubes with light pipes which provide a substantial background reduction. Applications of these instruments include the direct measurement of atomic-weapons produced radionuclide and cosmic-ray produced activation products in the atmosphere and the direct measurement of neutron activation products in water, soil, and biological materials. (auth)

36230 (K-P-3248) SAMPLING URANIUM HEXAFLUORIDE. McCluen, W. D. (Oak Ridge Gaseous Diffusion Plant, Tenn.). May 4, 1965. Contract W-7405-eng-26. 16p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

The problem of sampling enriched UF_6 for analysis from 5- and 12-in. ID cylinders filled by liquid drain or direct condensation is discussed. The various steps in the sampling operation are described: liquefaction, agitation and sampling position. Means for the verification of the sampling technique and precision of analyses are considered. (D.L.C.)

36231 (N64-27382) DEVELOPMENT OF NEUTRON ACTIVATION ANALYSIS PROCEDURES FOR THE DETERMINATION OF OXYGEN IN POTASSIUM. Quarterly Report No. 3, Period Ending March 31, 1964. Steele, E. L. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). June 19, 1964. Contract NAS3-2537. 19p. (NASA-CR-54099; GA-5339). CFSTI, $1.60 cy.

The principal effort was devoted to improvements in the equipment. Particular attention was given to the problem of neutron monitoring during irradiation. All manual operations, including transfer, timing, analyzer starts and stops, accelerator on and off, and neutron-flux determinations, were eliminated by an automatic control mechanism that steps the system through the entire procedure. A new device was designed and installed to insure a more uniform sample irradiation. Further development work was done on sample handling and encapsulation. Various metals and alloys were examined for residual oxygen content, and several cleaning techniques were investigated. Improvements were made in the detection system. A new detector that measures the high-energy beta particles from N rather than gamma rays was also investigated. (CFSTI)

36232 (PG-Report-585) ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF TOTAL NITROGEN IN ENRICHED URANIUM POWDER. (Production Group, United Kingdom Atomic Energy Authority, Springfields (England)). 1965. 10p. Dep.; $0.30(BIS); 1s. 9d.(HMSO)

Supersedes PG-Report-374.

Nitrogen, present as nitride, nitrite, or nitrate is converted to ammonia, separated by distillation, and determined absorptiometrically using sodium phenate and sodium hypochlorite reagent. The method is suitable for the determination of nitrogen in the range 10-500 ppm. The range may be extended up to 2000 ppm by taking a smaller aliquot of the sample solution. The standard deviation is 10 ppm at the 250 ppm level. (auth)

36233 (PG-Report-615) ANALYTICAL METHOD FOR THE SPECTROGRAPHIC DETERMINATION OF THORIUM IN MAGNOX ZR55 AND MAGZAN ALLOY. (Production Group, United Kingdom Atomic Energy Authority, Springfields (England)). 1965. 17p. Dep.; BIS, $0.60; HMSO, 3s.

The sample is dissolved in hydrochloric acid in the presence of a small amount of fluoride. Thorium and zirconium are separated from the magnesium by precipitation with ammonia, and the zirconium is then separated from thorium by extraction into chloroform as the cupferrate. Finally, the thorium is coprecipitated on ferric hydroxide and is determined spectrographically by the iron flux method using a Jarrell-Ash grating instrument. The method covers the range 1-125 ppm thorium with respect to sample, and is suitable for magnesium samples containing up to 0.65 wt % zirconium and 0.2 wt % manganese. The estimated precisions at the 3 sigma confidence level are: (a) with visual evaluation of the spectra, ±30% at the 5 ppm Th level and ±50% at other levels, and (b) with microphotometric evaluation of the spectra, ±30% at all levels. (auth)

36234 (PG-Report-649) ANALYTICAL METHOD FOR THE DETERMINATION OF TITANIUM IN PLUTONIUM NITRATE CONCENTRATE (TRI-N-OCTYL PHOSPHINE OXIDE EXTRACTION OF TITANIUM THIOCYANATE). (Production Group, United Kingdom Atomic Energy Authority, Sellafield (England)). 1965. 3p. Dep.; BIS, $0.20; HMSO, 10d.

Plutonium nitrate concentrate is converted to sulphate, which is dissolved in dilute sulphuric acid. Ammonium thiocyanate is added and titanium thiocyanate is extracted into tri-n-octyl phosphine oxide. The absorbancy of the yellow complex is measured. The precision (three times the standard deviation) is 10-15% at the 100-200 ppm with respect to Pu) level. The limit of detection is 1 μg of titanium. A nitrate concentration greater than 0.1M cannot be tolerated. Interfering ions are Nb(V), Ta(V), W(VI), and Mo(VI). (auth)

36235 (PG-Report-651) ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF COPPER IN PLUTONIUM SOLUTIONS (2.2'DIQUINOLYL METHOD). (Production Group, United Kingdom Atomic Energy Authority, Sellafield (England)). May 1965. 5p. Dep.; BIS, $0.20; HMSO, 1s. 2d.

Copper is determined absorptiometrically as the copper(I) 2,2' diquinolyl complex after extraction into amyl alcohol. The precision (three times standard deviation) is ±15%, the accuracy (bias) is negligible, the concentration range is 5-12 μg Cu in sample, and the limit of detection is 2 μg. The method is designed for the routine

inspection of plutonium solutions. It is of value when the amount of sample is strictly limited. (auth)

36236 (RCC-R-178) MEASUREMENT OF THE SPECIFIC ACTIVITY OF RESPIRED CARBON-14 DIOXIDE AS A METHOD OF HEALTH PHYSICS CONTROL. Cook, C. A.; Dancer, G. H. C. (Radiochemical Centre, Amersham (England)). May 1965. 13p. Dep.; BIS, $0.50; HMSO, 2s. 6d.

A method for the measurement of the specific activity of respired carbon-14 dioxide is described. The carbon dioxide is extracted from a breath sample into sodium hydroxide solution. It can be released, when required, by the addition of an excess of lactic acid and used as the 'filling' of a proportional counter. A limiting sensitivity of 3×10^{-9} μC carbon-14 per mil carbon dioxide is obtained. Some results of measurements on persons who work in a laboratory which processes many curies of carbon-14 annually are given. They show that large quantities of this material may be handled safely in standard fume cabinets and vacuum manifold systems. (auth)

36237 (RFP-111) RAPID ANALYSIS OF CADMIUM CYANIDE PLATING SOLUTIONS. Byrne, J. T.; Pflug, J. L.; Williams, A. K. (Rocky Flats Plant, Dow Chemical Co., Denver, Colo.). July 27, 1959. Contract AT(29-1)-1106. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The analytical data required for cadmium plating bath control can be obtained from a potentiometric titration curve and a separate cyanide determination on the sample. This method is much more rapid than conventional methods when hydroxide, carbonate, cyanide, and cadmium concentrations are required. Comparisons on synthetic solutions and on actual plating bath samples show the new procedure to be as accurate and reproducible as methods commonly used. The cadmium concentration is calculated by assuming that all combined cyanide in the titrated sample is in the form of $[Cd(CN)_3]^-$. The comparison of data indicates that this assumption is valid. (auth)

36238 (RFP-510) DIETHYLENETRIAMINEPENTAACETIC ACID ANALYSIS AND EXCRETION FOLLOWING THERAPY FOR PLUTONIUM EXPOSURE. Bokowski, D. L.; Hammond, S. E. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). May 7, 1965. Contract AT(29-1)-1106. 25p. (CONF-650616-1). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Health Physics Society, Annual Meeting, Los Angeles.

An analytical method for the determination of diethylenetriaminepentaacetic acid (DTPA) is described. Excess nickel sulfate is added to form the nickel salt of DTPA. Unreacted nickel is removed with dimethylglyoxime. After acidifying, dithiooxalic acid is added to form a colored complex which is compared with nickel standards. Urine samples from a subject treated for internal plutonium exposure were analyzed for DTPA. The results are compared with his plutonium excretion. The excretion curves of the two materials follow the same general pattern. Differences in the two curves are discussed. (auth)

36239 (TRG-Report-740) MEASUREMENT OF HELIUM ISOTOPE RATIOS BY MASS-SPECTROMETRIC COMPARISON WITH SYNTHETIC BLENDS (WITH A POSSIBLE APPLICATION TO THE LEAK TESTING OF LARGE RIGS). Fothergill, J. R.; Hamer, A. N. (Reactor Group, United Kingdom Atomic Energy Authority, Risley (England)). Nov. 23, 1964. 15p. Dep.; BIS, $0.50; HMSO, 2s. 6d.

The relative abundance of helium isotopes in a mixture was measured by comparison with synthetic blends of known compositions using a modified AEI Type MS3 mass spectrometer. A 'single collection' procedure with direct readout on a carefully calibrated desk meter gave a precision of 1.7×10^{-3} for a single comparison lasting 10 minutes. By intercalibrating a series of synthetic blends, the accuracy of the method was shown to be 2.5×10^{-3} (2σ). The procedure was applied to measure the relative abundance of small amounts of helium isotopes present in a large excess of carrier gas, during an evaluation of a new method of leak testing large sodium rigs based on an isotopic tracer technique. In this case, a preliminary separation of the helium from the carrier gas is required. The equipment used to do this introduced a small fractionation during sample transfer amounting to $1 \pm 1\%$. (auth)

36240 (TRG-Report-961) ANALYTICAL METHOD FOR THE VOLUMETRIC DETERMINATION OF MOLYBDENUM IN URANIUM–MOLYBDENUM ALLOY. Davies, W.; Gray, W. (Reactor Group, United Kingdom Atomic Energy Authority, Dounreay (Scotland)). Mar. 30, 1965. 6p. BIS, $0.30, HMSO, 1s. 3d.

A solution is prepared containing both the uranium and molybdenum in their hexavalent forms in concentrated hydrochloric acid. This is titrated potentiometrically with standard ferrous solution. The molybdenum is reduced to the pentavalent state during the titration. The bias is less than 0.5% of the molybdenum content, and the coefficient of variation is less than 1.0% of the molybdenum content, for alloys containing more than 8% wt/wt of molybdenum. The concentration range is 5 to 15% wt/wt of molybdenum. The method is applicable to the analysis of the uranium–molybdenum fast reactor fuel element alloy. (auth)

36241 (TRG-Report-962) ANALYTICAL METHOD FOR THE DETERMINATION OF 137-CAESIUM IN FISSION PRODUCT SOLUTIONS USING A CARRIER-FREE EXTRACTION PROCEDURE. Davies, W.; Diggle, W. R. (Reactor Group, United Kingdom Atomic Energy Authority, Dounreay (Scotland)). Mar. 30, 1965. 8p. Dep., BIS, $0.30; HMSO, 1s. 6d.

The cesium-137 is extracted into amyl acetate as cesium tetraphenylborate from an alkaline aqueous solution containing ethylenediamine tetraacetate. No inactive cesium is added. The amount of cesium-137 extracted is determined by a γ counting procedure applicable to liquid sources. Interference from radioruthenium is reduced by warming the alkaline solution and then cooling to room temperature prior to the extraction. The bias is dependent on the cesium-137 radiometric standard which is calibrated to an accuracy of ±2%. The coefficient of variation is 2% to 3% when applied to 1×10^6 dpm of pure cesium-137 tracer solution. The concentration range is 1×10^5 to 2×10^6 dpm of cesium-137 per aliquot. The method is applicable to nitric, hydrochloric, or sulphuric acid solutions of irradiated plutonium and uranium prepared for the determination of burn-up after a cooling time of at least three months. Potassium must be absent. The cesium-134 activity must be 2% to 50% of the cesium activity in order to make a correction for it. (auth)

36242 (TRG-Report-963) ANALYTICAL METHOD FOR THE THERMOGRAVIMETRIC DETERMINATION OF THE OXYGEN/METAL RATIO OF URANIUM–PLUTONIUM OXIDES. Drummond, J. L.; Chapman, H. (Reactor Group, United Kingdom Atomic Energy Authority, Dounreay (Scotland)). Mar. 30, 1965. 4p. Dep.; BIS, $0.20; HMSO, 10d.

The oxide, after oxidation in air at 1000°C, is reduced in hydrogen at 1200°C to the stoichiometric oxide. The difference in weight between the initial and reduced weights is related to the oxygen/metal ratio of the sample. The bias on the oxygen/metal ratio is less than 0.01. The standard deviation on the oxygen/metal ratio is less than 0.004. The concentration range is oxygen/metal ratios from 1.8 to 2.3 for any ratio of plutonium to uranium. The method is applicable to uranium oxide, plutonium oxide, and mixed plutonium/uranium oxides, either as powders or sintered granules or pellets. (auth)

36243 (X64-17610) AN INVESTIGATION OF COMPUTER-COUPLED, AUTOMATIC, REMOTE ACTIVATION ANALYSIS FOR LUNAR SURFACE ANALYSIS. Semi-annual Report, May 1-November 1, 1964. Menon, Manchery P. (Texas Agricultural and Mechanical Univ., College Station. Activation Analysis Research Lab.). 101p. (NASA-CR-59347).

The instrumentation, sample analysis, and data reduction fundamental to the use of nuclear activation analysis of the lunar surface are being investigated. The study program

includes the following: (1) detector research—the problem of Compton interactions in the analysis of multielement samples and the use of an anticoincidence detecting system; (2) analysis of geological samples for most probable lunar-surface elements with the use of 14.5 Mev neutrons; (3) determination of cerium, praseodymium, and yttrium in ores and minerals by using neutron-activation analysis; (4) determination of uranium and thorium content of lunar mineral deposits by measuring the natural gamma activity; (5) application of linear estimation to a chemical-mixture problem; and (6) digital-computer analysis of pulse-height spectra. (CFSTI)

36244 (JPRS-30907) EXTRACTIONAL COLORIMETRIC DETERMINATION OF SMALL AMOUNTS OF THORIUM IN THE ATMOSPHERE. Pavlovskaya, N. A. Translated from Gigiena Truda i Prof. Zabolevaniya, No. 9, 59-60 (Sept. 1964). 5p. (TT-65-31406). CFSTI, $1.00 cy.

A method was developed for determining Th in the air of industrial enterprises. Th is separated from interfering impurities by extraction with a solution of ammonium phenylzirconate in n-butanol in the presence of ascorbic acid. Th is then determined colorimetrically with thorone or radiometrically. The sensitivity of the method is 5 γ per sample, and the error is no more than 25%. Ti and Zr do not interfere. (D.L.C.)

36245 (NP-tr-1271) FRACTOMETRIC ANALYSIS OF DEUTERIUM IN A CURRENT OF HYDROGEN. Riedel, O.; Uhlmann, E. Translated by A. Crozy (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Z. Anal. Chem., 166: 433-9(1959). 14p. Dep. mn; JCL, $1.60 fs, $0.80 mf.

A gas chromatographic method was developed for analysis of deuterium and hydrogen in deuterium-labeling work. The samples are transformed into elementary hydrogen before being fed into the apparatus. A catharometer cell is used as the detector, and a molecular sieve with hydrogen carrier is used in the column. The chromatogram shows a measurable peak which is linearly proportional to the deuterium content. Hydrogen deuteride HD behaves as if it were $\frac{1}{2}D_2$. (D.L.C.)

36246 MEASUREMENT OF $^{14}CO_2$ IN THE LIQUID SCINTILLATION COUNTER WITH β-PHENYLETHYLAMINE IN A DIOXANE-NAPHTHALENE MIXTURE. Georgi, P.; Lober, M.; Wangermann, G. (Ernst-Moritz-Arndt Universitaet, Greifswald, Ger.). Acta Biol. Med. Ger., 13: 629-32(1964). (In German)

Absolute methanol was added to solutions of a toluol scintillator to prevent crystallization out of phenylethyl ammoniumphenylethyl carbamate. However, addition of as little as 0.5 ml of absolute methanol to a toluol-PPO-POPOP scintillator solution reduced the count obtained from ^{14}C by ~50%. The toluol solution was replaced by a dioxane-naphthalene scintillator mixture. This dioxane-naphthalene mixture had greater counting efficiency for $^{14}CO_2$ and greater solubility as compared to other solvent systems containing toluol, dioxane, PPO, or POPOP. For measurement of ^{14}C-carbamate the relative count rate in the dioxane-naphthalene solution was 65.7% as against 50.7% as compared to a toluol scintillation solution. It is possible that the naphthalene reduces the solubilizing effect of the methanol contained in the absorption solution. Since the absorption solution takes up water during the incubation of biological samples, the use of a dioxane-naphthalene mixture which can take up as much as 20% water, could be very advantageous. (BBB)

36247 TRITIUM ASSAY BY COMBUSTION WITH A NOVEL OXYGEN TRAIN AND LIQUID SCINTILLATION TECHNIQUES. Knoche, H. W.; Bell, Robert M. (Univ. of Nebraska, Lincoln). Anal. Biochem., 12: 49-59 (July 1965).

A method is reported for the analysis of tritium in biological samples weighing between 0.1 and 2 g. This method, offering advantages over previous methods, employs a combustion tube of new design in an oxygen train. The tube design permits the oxidation and simultaneous collection of tritiated water in 10 min for samples weighing 600 to 800 mg. Coupling the method with the channels ratio method of liquid scintillation counting allows the procedure to be independent of sample weight and dryness. Samples of low activity (500 dpm) or series of samples varying in radioactivity may be assayed accurately because of the low memory effect of the train. Criteria used to assess the accuracy of the method were the percentage recoveries of tritium from groups of samples varying in weight, radioactivity, biological source, and chemical form of the tritium added. The recoveries and standard deviations of these different groups ranged from 99.4 to 96.6 and 1.2 to 3.5%, respectively, thus indicating the accuracy of the method from the analysis of tritium in biological samples and its suitability for samples of various weights and activities. (auth)

36248 REACTOR NEUTRON ACTIVATION ANALYSIS BY THE SINGLE COMPARATOR METHOD. Girardi, Francesco; Guzzi, Giampaolo; Pauly, Jules (Centro Comune di Ricerche Euratom, Ispra, Italy). Anal. Chem., 37: 1085-92 (Aug. 1965).

A method of activation analysis, based on the irradiation and counting of a single comparator (cobalt) instead of standards prepared from known weights of the elements to be determined, was critically evaluated. The influence of the variation of experimental parameters such as reactor neutron spectrum, neutron flux, and yield of γ spectrometers, was studied. In a series of trial runs the accuracy and precision were found to be similar to those of the relative method. The method can find most useful applications in automated analysis, or when a large number of elements are determined in one sample. (auth)

36249 MASS ANALYSIS OF SUBNANOGRAM QUANTITIES OF IODINE. McHugh, J. A.; Sheffield, J. C. (General Electric Co., Schenectady, N. Y.). Anal. Chem., 37: 1099-1101(Aug. 1965).

A mass spectrometric method employing an ion source that generates ions by sputtering was used in obtaining the isotopic abundance analysis from nanogram quantities of iodine. Negative iodine ions were mass analyzed in a spectrometer composed of two magnetic sectors followed by an electrostatic analyzer. The high abundance sensitivity ($>10^7$:1) permitted minute quantities of ^{129}I to be measured in the presence of large amounts of normal ^{127}I. This method has direct application in studies utilizing ^{129}I tracer. The sensitivity of the method was sufficiently high that 10^{-13} gram of a given iodine isotope can be detected in a sample. (auth)

36250 DETERMINATION OF STRONTIUM IN ENVIRONMENTAL MEDIA USING NEUTRON ACTIVATION. Magno, Paul J.; Knowles, Forrest E. Jr. (Northeastern Radiological Health Lab., Winchester, Mass.). Anal. Chem., 37: 1112-15(Aug. 1965).

A neutron activation procedure for the determination of strontium in environmental media is described. The method presented simplifies the handling and flux monitoring problems associated with activation analyses. Prior to irradiation, the strontium was separated from the sample by oxalate and nitrate precipitations using the calcium present in the sample as a carrier. Copper was then added to the purified strontium as an internal monitor and the sample was irradiated in a thermal neutron flux of $10^{12}/cm^2/sec$. After irradiation, strontium carrier was added and the strontium further purified by nitrate and chromate precipitations. Copper was separated by dithizone extraction and the strontium was then calculated from the induced activities of ^{87m}Sr and ^{64}Cu ^{85}Sr was used to measure the strontium recovery. This method was applied to the determination of strontium in food, milk, bone, hair, and blood. (auth)

36251 APPLICATION OF LITHIUM-DRIFTED GERMANIUM γ-RAY DETECTORS TO NEUTRON ACTIVATION ANALYSIS. NONDESTRUCTIVE ANALYSIS OF ALUMINUM. Prussin, S. G.; Harris, J. A.; Hollander, J. M. (Univ. of Calif., Berkeley). Anal. Chem., 37: 1127-32(Aug. 1965). (UCRL-16028)

A lithium-drifted germanium gamma spectrometer was utilized for the nondestructive analysis of aluminum by neutron activation. Because of the much higher resolving power of these semiconductor detectors in comparison to the widely used sodium iodide scintillators, a marked simplification was achieved in the analysis of samples yielding complex gamma spectra. Fractional parts-per-million concentrations of Mn, Sc, Hf, and Cr were readily detected and analyzed nondestructively in 99.9999% aluminum. (auth)

36252 SOLVENT EXTRACTION STUDIES WITH A HYDROCHLORIC ACID-2-ETHYLHEXANOL SYSTEM. Orlandini, K. A.; Wahlgren, M. A.; Barclay, J. (Argonne National Lab., Ill.). Anal. Chem., 37: 1148-51(Aug. 1965).

The distribution of 45 elements between 83% 2-ethylhexanol-17% petroleum ether and hydrochloric acid solutions was determined. A graphic presentation of the extraction data as a function of acid concentration is given. Very efficient extraction of Ti(IV), V(V), Ru(VIII), Sn(IV), Pa(V), Nb(V), Ta(V), Ga(III), Fe(III), Sb(V), Au(III), As(III), Np(VI), and Mo(VI) was achieved. Of the remaining elements studied, only W(VI), Zn(II), U(VI), Tc(VII), Cd(II), Hg(II), and Pd(II) were appreciably extracted. Separations within the group of well-extracted elements can be accomplished by back-extraction utilizing selective reduction, complexation, and variation of acid concentration. The extracted elements were readily stripped into dilute acid solution or water. A number of applications of the system to activation analysis as well as other radiochemical separations, including preparation of some carrier-free samples, are given. (auth)

36253 THE NEUTRON ACTIVATION DETERMINATION OF LITHIUM IN THE PRESENCE OF ALKALI METALS AND MAGNESIUM. Smith, Gilbert W.; Santelli, Dino J.; Fiess, Harold (Argonne National Lab., Ill.). Anal. Chim. Acta, 33: 1-12(July 1965).

A neutron activation method for lithium in the presence of alkali metals or magnesium was developed, utilizing the $^{6}Li(n,\alpha)^{3}H$ and $^{16}O(t,n)^{18}F$ nuclear reactions. After a short thermal neutron irradiation with a lithium standard, 112-min ^{18}F was separated by a lead chlorofluoride precipitation. The annihilation photons from the separated ^{18}F were counted using 2 sodium iodide detectors, a fast-slow coincidence system, and a multichannel analyzer. Precision in a synthetic 1.0% lithium-in-sodium matrix was found to be ±2.0% standard deviation, whereas the accuracy of the method was estimated to ±3% or better. The ultimate sensitivity in pure solution was estimated to be about 0.2 ppb and in a sodium matrix about 0.5 ppm. The only interferences were several positron emitters, easily discriminated from by chemical separation, decay, or by means of other nuclear parameters. Three hours were required for a duplicate determination, following initial sample preparation and dilution. To use the method, the lithium isotopic abundance must be known or determined by mass spectrometry because of the prevalence of depleted lithium in metal and salts. (auth)

36254 NEUTRON ACTIVATION ANALYSIS OF SCANDIUM. Hamaguchi, H.; Watanabe, T.; Onuma, N.; Tomura, K.; Kuroda, R. (Tokyo Kyoiku Univ.). Anal. Chim. Acta, 33: 13-20(July 1965).

A neutron activation method was proposed for the determination of trace quantities of scandium, down to submicrogram level, in rocks, ores, and meteorites. The sample and standard were irradiated intermittently for a total of 30 hr, at a neutron flux of 5×10^{11} n/cm^2/sec. The radiochemical separation consisted essentially of a one-step anion exchange. The induced γ activity of ^{46}Sc, with a half-life of 85 days, isolated from the sample, was measured and compared with that of a standard. The chemical yield averages 85% and there was a considerable saving of time in the radiochemical work. Results were quoted for the scandium contents of 2 standard rocks, cassiterite, and several stony meteorites. Details of conflicting nuclear reactions are also given. (auth)

36255 EFFECT OF COBALT-60 GAMMA RADIATION ON THE DETERMINATION OF URANIUM(VI) IN PHOSPHORIC ACID SOLUTIONS OF URANIUM(IV) OXIDE. Kochanny, G. L., Jr. (Oak Ridge National Lab., Ill.). Anal. Chim. Acta, 33: 76-83(July 1965). (ORNL-P-455)

The effects of ^{60}Co γ radiation on aerated and deaerated phosphoric acid solutions of uranium(IV) oxide (UO_2) were studied as a function of temperature, concentration of UO_2, and radiation dose rate. The effect was measured in terms of the radiolytic yield of uranium(VI), $G_{U(VI)}$. For solutions of high initial UO_2 concentration, $G_{U(VI)}$ was largest for the aerated solutions at 25°C; it was lowest for the deaerated solutions at 140°C. The $G_{U(VI)}$ was lower for the solution of low initial UO_2 concentration than for any of the solutions of high initial UO_2 concentration. At the high starting UO_2 concentration, the initial $G_{U(VI)}$ values were always higher than the succeeding values; this effect was attributed to the depletion of oxygen originally present in the solution. Gamma radiation caused an error in the determination of the stoichiometry of UO_2; the error was a function of the radiation dose. This error could be minimized by excluding oxygen from solutions of UO_2 and by keeping the initial UO_2 concentration as low as possible. (auth)

36256 THE DETERMINATION OF CHLORINATED HYDROCARBONS IN THE ATMOSPHERE BY ACTIVATION ANALYSIS. Morgan, D. J.; Duxbury, G. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Ann. Occupational Hyg., 8: 253-6(July 1965).

An air sample containing about 10mg of chlorinated hydrocarbon was drawn through a small charcoal pack by means of a battery-operated air sampler. The charcoal was then placed in a neutron flux and the ^{38}Cl formed was determined by γ spectrometry. The results of an operational investigation are described. (auth)

36257 AUTOMATED FAST NEUTRON ACTIVATION ANALYSIS. Ehmann, William D. (Australian National Univ., Canberra). At. Energy Australia, 8: 10-14(Apr. 1965).

The principles, economics, and techniques, and developments in automated fast neutron activation analyses are discussed. Two practical examples are cited that illustrate the speed and precision that can be obtained using a fast neutron activation technique for two elements (oxygen and silicon) whose determinations are ordinarily tedious and time consuming by use of conventional techniques. (P.C.H.)

36258 NEUTRON ACTIVATION ANALYSIS IN METALLURGY. Malvano, R. (Sorin Centro Ricerche Nucleari, Saluggia, Italy). Atompraxis; 6: 309-14(June 1965).

The use of neutron activation analysis in metallurgy, especially in connection with preparation and study of high-purity materials, is described and reviewed. On the basis of a literature survey and experimental work carried out at the Sorin Nuclear Center, the potentiality and the applications of the method are discussed, and some examples of practical interest are reported. (auth)

36259 A UNIVERSAL SAMPLE CHANGER FOR GAMMA SPECTROMETRY. Robin, G. (Societe l'Atome Industriel, Paris). Atompraxis, 6: 325-7(June 1965). (In French)

Sample changers of general use are designed to admit only standard size samples (planchets or tubes) and are used for β or γ gross counting (well crystal). In activation analysis, or more generally gamma spectrometry, very different geometrical conditions are imposed, to take full advantage of the resolution of detectors. Moreover, samples may have widely varying shapes and volumes. A sample changer meeting these specifications is described. It is adaptable without important alterations to any gamma spectrometry shield. (auth)

36260 MEASUREMENT SENSITIVITY IN DETERMINATION OF HYDROGEN CONTENT BY MEANS OF NEUTRONS. Johannes, E. (VEB Vakutronik, Dresden, Ger.). Atompraxis, 6: 330-5(June 1965). (In German)

Using the elementary age theory, the measurement sensitivity in hydrogen-content determination was calculated

by means of the neutron retrodiffusion method in the case of spherical symmetry. The relations thus obtained were compared qualitatively with experimental results. Calculations and measurements were in agreement in indicating the existence of an optimum size of the measurement volume for each hydrogen-concentration measurement interval, i.e., a size, which provides maximum measurement sensitivity. The significance of the results is illustrated by means of a practical measurement problem. (auth)

36261 A FAST AND SIMPLE METHOD FOR DEMONSTRATING TRITIUM IN BIOLOGICAL MATERIAL. Daruschy, P. (Landesinstitut fuer Arbeitsschutz und Arbeitsmedizin, Karlsruhe, Ger.). Atompraxis, 11: 273-4(May 1965). (In German)

A rapid method for determining tritium in biological material is described. The water containing the tritium is removed from the material with the aid of simple xylem distillation, and is then measured in a liquid scintillation counter. (auth)

36262 OPERATIONAL CONTROL OF THE APPLICABILITY OF ACTIVATION ANALYSIS TO THE BAUXITE INDUSTRY. Tatar, Janos. Atomtech. Tajekoztato, 8: 15-17(1965). (In Hungarian)

The large capture cross section of Al and Si and the 2.3-min half life of ^{28}Al make it possible to use activation analysis for the rapid determination of Al_2O_3 and SiO_2 in Al ores. A 5 to 10 C Po–Be neutron source was employed to produce the slow neutrons needed for the $^{28}Si(n,\gamma)^{28}Al$ reaction. The sample was shielded with a Cd sheet when the $^{28}Si(n,p)^{28}Al$ fast-neutron reaction was used. The SiO_2 values obtained in field tests of the method developed by workers at the Geophysical Laboratory agreed well with the chemical data but the Al_2O_3 values were not consistently reliable. The conditions set were satisfied in 71% of the cases. The activation analysis could be carried out in about 9 min. (TTT)

36263 NEUTRON ACTIVATION ANALYSIS FOR TRACES OF SODIUM IN POLYCARBONATE. Kamada, Hitoshi; Ujihara, Yusuke; Fukuda, Katsuaki; Keimatsu, Shotaro; Tsurumi, Yoshihiro (Tokyo Univ.). Bull. Chem. Soc. Japan, 38: 1220-1(July 1965).

A half to two grams of the polycarbonate sample was sealed in a polyethylene pouch and, together with a standard sample, irradiated for 2 hr in the JRR-1, which produces a neutron flux of about 10^{11} n/cm^2 sec. The irradiated sample was washed with nitric acid and water. No activity was found in the washings. The standard sample was prepared by impregnating a filter paper with 1 mg of sodium, then drying the paper under an infrared lamp. After irradiation, the sodium was extracted with water. A representative γ spectrum of the irradiated polycarbonate is shown. The activity of ^{38}Cl (half life, 37 min) was dominant shortly after the irradiation. This activity would have come from a $^{37}Cl(n,\gamma)^{38}Cl$ reaction, since methylene chloride was employed as the solvent in the production of the polycarbonate. After the ^{38}Cl activity had decayed, only the activity of ^{24}Na remained and this was counted at convenient intervals. (F.J.H.)

36264 THE DEUTEROXIDE-CATALYZED HYDROGEN EXCHANGE OF DIMETHYL SULPHOXIDE. PREPARATION OF DIPERDEUTEROMETHYL SULPHOXIDE, $(CD_3)_2SO$. Buncel, E.; Symons, E. A.; Zabel, A. W. (Queen's Univ., Kingston, Ont.). Chem. Commun., No. 9, 173-4(May 12, 1965).

Dimethyl sulfoxide was observed to undergo hydrogen exchange in the presence of sodium deuteroxide under very mild conditions. This ready exchange affords a convenient and inexpensive method for the preparation of deuterated dimethyl sulfoxide. Reaction mechanisms are discussed. (C.H.)

36265 TITRATION OF URANIUM(IV) WITH CERIUM(IV) SULFATE USING SETOCYANINE OR XYLENE CYANOLE FF AS INDICATOR. Rao, K. Bhaskara (Hindustan Aircraft Ltd., Bangalore, India). Chemist-Analyst 54: 70-1 (July 1965).

Studies showed that U(IV) can be titrated with Ce(IV) sulfate at room temperature without the addition of phosphoric acid by the use of either Setocyanine or Xylene Cyanole FF as indicator. Both of these indicators function satisfactorily in 0.25–2.5 M sulfuric acid or 0.5–5 M perchloric acid giving a sharp end point and a negligible titration error. However, these indicators cannot be used in HNO_3 or HCl. (P.C.H.)

36266 RADIOMETRIC END POINT DETECTION IN TITRATIONS USING A "KRYPTONATE"—TITRATION OF FLUORIDE. Maehl, R.; Cucchiara, O.; Chleck, D. (Parametrics, Inc., Waltham, Mass.). Chemist-Analyst, 54: 83-4(July 1965).

The use of a kryptonate for the radiometric end point indication of a titration where the solid carrier reacts with the titrant, when present in excess, but not with the solution being titrated, is reported. The technique is described for the microtitration of fluoride with thorium using zinc kryptonate. The mechanism of the end point indication may well be the acid attack on the zinc following the addition of an excess of the thorium nitrate titrant solution (pH 3.4 owing to the hydrolysis of thorium). When 0.029 mmoles of fluoride was titrated by the method, the result obtained was 0.029 mmoles. Reproducibility of this titration was satisfactory. The end point was detectable using zinc kryptonate as the indicator at a fluoride level as low as 0.001 mmole. (P.C.H.)

36267 NEW TECHNIC FOR SOLUTION ANALYSIS EMPLOYING A "KRYPTONATE"—ACIDITY OF AQUEOUS SOLUTIONS AND WATER IN METHANOL. Chleck, D.; Maehl, R.; Cucchiara, O. (Parametrics, Inc., Waltham, Mass.). Chemist-Analyst, 54: 84-6(July 1965).

Two methods are described for the determination of the acidity of aqueous HCl using magnesium kryptonate and the determination of water in methanol using kryptonated calcium carbide. The results showed that the sensitivity of the determinations of water might be improved by the use of efficient shielding to reduce the count background of a chamber of a higher counting efficiency, and of calcium carbide having a higher specific activity. (P.C.H.)

36268 POLAROGRAPHIC BEHAVIOR OF YTTERBIUM ON MERCURY-DROPPING AND MERCURY-SUSPENSION ELECTRODES. Tung, Shao-chun; Wang, Erh-kang. Chung-Kuo K'o Hsueh Yuan Ying Yung Hua Hsueh Yen Chiu So Chi K'an, No. 6, 36-41(1962).

Experiments were conducted to study the polarographic behavior of ytterbium on mercury-dropping and mercury-suspension electrodes in 0.4M potassium chloride and lithium chloride. Vogel mercury-suspension electrodes were used. The polarograph has a sweeping time of 2 sec, a time interval of 5 sec, and a voltage increase rate of 0.3 v/sec. The mercury dropping speed was set at 0.545 mg/sec. Experiments were carried out in a Kalousek electrolytic cell at 25 ± 0.5°C. A saturated calomel electrode was used as the reference electrode. The purity of ytterbium oxide was 99%. The peak current of ytterbium in 0.4M lithium chloride, potassium chloride, and lithium acetate was found to increase with the increasing height of a mercury column. Rare earth impurities were found to have no interference in ytterbium determination. It was concluded that polarographic determination of ytterbium in 0.4M potassium chloride (or lithium chloride) using a mercury-suspension electrode is rapid and accurate. The error is ±3.5%. (CFSTI)

36269 POLAROGRAPHIC BEHAVIOR OF EUROPIUM OF MERCURY-DROPPING AND MERCURY-SUSPENSION ELECTRODES. Tung, Shao-chun. Chung-Kuo K'o Hsueh Yuan Ying Yung Hua Hsueh Yen Chiu So Chi K'an, No. 6, 42-7(1962).

Experiments were conducted to study the polarographic behavior of europium on mercury-dropping and mercury-suspension electrodes in different electrolytes. A rapid method was found for europium polarographic determination in light rare earth mixtures. The purity of the europium oxide used in the experiment was 99%. The peak

current of europium was found to increase with decreasing electrode surface area. The polarographic behavior of europium in 0.4M tartaric acid, sulfosalicyclic acid, potassium chloride, and lithium chloride obeyed the Randles Sevcik equation. The temperature coefficient of europium in 0.4M sulfosalicyclic acid and potassium chloride was found to be, respectively, 1.20% and 1.13% at 0 to 50C. The presence of samarium oxide or other rare earths did not interfere with polarographic europium determination. Polarographic determination of europium was carried out at a sweeping voltage of −0.4 to −1.0 v. The determination error was found to be ±3%. Experiments were also conducted to study the polarographic behavior of europium on Vogel mercury-suspension electrodes in 0.4M potassium chloride. The peak current was found to obey the Frankenthal and Shain equation. It was concluded that mercury-suspension electrodes have a high sensitivity in europium determination. (CFSTI)

36270 ISOTOPIC ANALYSIS OF ^{239}Pu AND ^{240}Pu MIXTURES BY THE DOUBLE NUCLEAR EMULSION METHOD. Faraone, Giovanni; Trozzi, Marcello (Universita, Messina, Italy and Centro Nazionale per la Chimica delle Radiazioni e dei Radioelementi (CNR), Padua). Ric. Sci. Rend., Sez. A, 7: 659-70(Dec. 1964). (In Italian).

The double nuclear emulsion technique was used for isotopic analysis of a ^{239}Pu-^{240}Pu mixture. Quantities of about 10^{-12} g plutonium were included in nuclear emulsion and after an appropriate exposure time, all the alpha and electronic emissions were counted by microscopic scanning. The ratio $^{240}Pu/^{239}Pu$ was determined from the percentage of alpha tracks with conversion electron coincidences and from their known percentage in the two isotopes. The possibility of employing the nuclear emulsion to distinguish the two isotopes and of determining the ratio between the half lives of ^{239}Pu and ^{240}Pu is discussed. The accuracy of the method depends on the centesimal composition of the mixture, the statistical error of radioactive disintegration, and the approximation in the determination of the percentage of conversion electron coincidences in each of two isotopes. (auth)

36271 CHROMATOGRAPHY ON SPECTROGRAPHIC CARBON ACCORDING TO HAFTKA. Tlalka, R. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 30: 1433-40 (May 1965).

Studies of the adsorption of the radioisotopes ^{24}Na and ^{64}Cu on porous electrodes made of organic carbon are described. An increase of the cation concentration was proved after the Haftka procedure. A parabolic distribution of the concentration of Na^+ and Cu^{2+} ions along the axis of the electrode and the chromatographic separation of the anion and cation was ascertained with the aid of autoradiography of slices of these electrodes. (auth)

36272 SORPTION OF THE RADIOISOTOPES ^{32}P AND ^{35}S AS THE PHOSPHATE AND SULFATE ANIONS OF IONIC PRECIPITATES. Kepak, F. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 30: 1441-55(May 1965).

Sorption of the radioisotope ^{32}P as the phosphate on barium sulfate, natural barites, and barium carbonate and sorption of ^{35}S as the sulfate on barium carbonate was studied in order to determine the sorption properties of these sorbents for the purpose of decontamination of the mentioned radioisotopes from aqueous solutions and for closer definition of the sorption mechanism of both anions on ionic precipitates. Barium sulfate as well as the mineral barites are satisfactory sorbents of the phosphate anion and are suitable also for practical application. Barium carbonate is a less suitable sorbent for the phosphate anion, sorption of the sulfate anion was ineffective on this sorbent. (auth)

36273 SORPTION OF ^{35}S AS THE SULFATE ANION BY ISOTOPIC EXCHANGE ON BARIUM SULFATE AND NATURAL BARYTES. Kepak, F. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 30: 1456-63(May 1965).

The isotopic exchange of the radioisotope ^{35}S was studied as the sulfate anion between precipitated barium sulfate or natural barites and the aqueous phase. The isotopic exchange was not effectuated only between the surface of the precipitate and the solution but recrystallization proceeded into the deeper layers of the solid phase. The sulfate anion can be sorbed on the sorbents from solutions in which it is present in low concentrations, however, the fraction of isotopic exchange decreases from solutions with higher sulfate concentration. The artificial as well as the natural material are suitable for the sorption of the radioactive sulfate ion, which is not accompanied by higher concentrations of inactive sulfate. (auth)

36274 SORPTION OF THE RADIOISOTOPES ^{35}S AND ^{32}P AS THE SULPHATE AND PHOSPHATE ANION ON HYDRATED OXIDES. Kepak, F. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 30: 1464-72(May 1965).

The sorption of the radioisotopes ^{35}S and ^{32}P as the sulfate and phosphate anion was studied from the aqueous phase on hydrated iron(III), aluminium(III), and zinc(II)-aluminium(III) oxide. The dependence of sorption on pH, the sorption kinetics, the sorption isotherm, the influence of the presence of nitrate on the sorption equilibrium were determined and conclusions were drawn from these data on the sorption properties of these sorbents for both anions. All three oxides showed suitable sorption properties and could be practically employed for the decontamination of both radioisotopes from aqueous solutions. (auth)

36275 ACTIVATED BARIUM SULPHATE AS A SORBENT OF SMALL QUANTITIES OF STRONTIUM. Berak, L. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 30: 1490-1504(May 1965).

The effects of contamination with calcium sulfate of precipitated barium sulfate on the sorption capability of barium sulfate for small quantities of strontium from the solution of calcium salts were investigated. The optimum conditions of activation were found and the reaction mechanism is explained. (auth)

36276 THE ZINC CONTENTS OF SOME GEOCHEMICAL STANDARDS BY NEUTRON ACTIVATION AND X-RAY FLUORESCENCE ANALYSIS. Ball, T. K.; Filby, R. H. (Univ. of Oslo), Geochim. Cosmochim. Acta, 29: 737-40 (July 1965).

Zinc contents of G-1 and W-1 were studied by two independent methods in order to establish the zinc contents with more certainty, in addition to providing data on the zinc contents of some other geochemical standards. Both methods used in the study were subject to interferences and these had to be evaluated and corrected. The neutron activation method was subject to interference mainly from fast neutron reactions $^{69}Ga(n,p)^{69m}Zn$ and $^{72}Ge(n,\alpha)^{69m}Zn$. The major interference with the x ray fluorescence method was the absorption effect with increasing iron contents. (F.J.H.)

36277 THE APPLICATION OF NEUTRON-ACTIVATION FOR QUICK ANALYSIS OF BAUXITES. Tatar, Janos. Geofiz. Kozlemen., 13: 463-75(1964). (In Hungarian)

An analysis based on neutron-activation determined the aluminum and silicon contents of a bauxite sample in 9 minutes. According to a statistical calculation of 300 tests, the mean value of the differences of neutron-activation and chemical analyses is +1.12 ± 2.43% for Al_2O_3 and −0.03 ± 2.01% for SiO_2. The rapid process discussed meets industrial demands. (auth)

36278 THE APPLICATION OF NUCLEAR GEOPHYSICS TO DETERMINE THE QUALITY OF COALS. Tatar, Janos. Geofiz. Kozlemen., 13: 477-93(1964). (In Hungarian)

In order to support coal reserves estimation nuclear well logging supplies exact figures for both quantity and quality of penetrated coal beds. Technical characteristics of the

ashes and data essential in coal prospecting are discussed. It is shown that neutron activation analysis is a useful procedure in coal laboratories. (auth)

36279 DETERMINATION OF PLUTONIUM IN URINE BY ANION EXCHANGE. Campbell, Evan E.; Moss, William D. (Los Alamos Scientific Lab., N. Mex.). Health Phys., 11: 737-42(Aug. 1965).

Plutonium is concentrated from urine by coprecipitation with alkaline earth phosphates. The precipitate is dissolved in 8 N nitric acid and the plutonium adsorbed from that solution onto a Dow anion exchange resin. Interfering anions adsorbed on the column are removed with 12 N hydrochloric acid. The plutonium is eluted from the column with specially prepared hydrochloric and hydriodic acids, and the alpha activity determined either by direct planchetting or by electrodeposition of the eluate, followed by standard alpha-counting techniques. The problems of determining plutonium in urine are discussed and the advantages of the method presented over other procedures are described. The recovery of 0.5 dpm of plutonium from a liter of urine is 84 ± 14 per cent. (auth)

36280 SEPARATION AND DETECTION OF THORIUM AND ZIRCONIUM BY RING OVEN TECHNIQUE. Shun, Shih-nien; Gun, Sing-to; Kong, Ding-sho. Hua Hseuh Tung Pao, No. 3, 59-60(Mar. 14, 1965). (In Chinese)

The circular furnace technique was employed for the separation of Zr and Th, using α-nitrobenzoic acid for the spot precipitation of Zr. The not-precipitated Th was washed with 0.2N HNO_3 to the rim of the furnace along the filter paper while making sure that the precipitate remained on the spot. After drying the strip, the Zr was identified by conventional methods at the spot, the Th likewise at the rim. The technique makes it possible to estimate quantitatively 0.2 to 5 μg of Zr in mixtures containing 0.1 to 500 μg of Th. Traces of Th can also be identified in mixtures containing as much as 700 μg of Zr. The lower sensitivity limit for detecting Zr is 0.1 μg at the spot and for Th 0.2 μg at the rim. By using narrower filter paper strips, the sensitivity for Zr may be extended down to 0.05 μg. The whole process requires only 10 to 15 minutes. The presence of the common quadrivalent ions, such as Sn^{4+}, Ce^{4+}, and of Hg^{2+} does not interfere with the determination. (TTT)

36281 DETERMINATION OF TRACES OF MOLYBDENUM IN URANIUM. Jogdeo, S. M.; Mahajan, L. M. (Atomic Energy Establishment, Trombay, India). Indian J. Chem., 3: 229-30(May 1965).

A method is described for the separation and spectrophotometric determination of molybdenum in nuclear grade uranium. Mo(VI) is separated from interfering elements by extracting its chloride complex in amyl acetate and then stripping it with water. The strippings are neutralized with alkali, pH adjusted to 4 after the addition of thioglycollic acid and the absorbancy of the mixture measured at 365 mμ. The method is applicable to samples of uranium containing 2 ppm molybdenum. (auth)

36282 PREPARATION OF SAMPLES FOR MASS-SPECTROMETRIC ANALYSIS OF NITROGEN-15. Paul, S. D.; Krishnan, M. S. (Atomic Energy Establishment, Trombay, India). Indian J. Chem., 3: 230-1(May 1965).

A modified discharge method and a thermal decomposition method are described for the preparation of samples for mass spectrometric determination of ^{15}N. Both the methods have several advantages over other methods in use such as complete removal of oxygen by copper strips, lower discharge voltage, and the elimination of the degassing step in the samples of nitric acid. (auth)

36283 ESTIMATION OF RADIOCARBON BY GAS-PHASE COUNTING AS $^{14}CO_2$. Soman, S. D.; Iyengar, T. S.; Sadarangani, S. H.; Vaze, P. K. (Atomic Energy Establishment, Trombay, India). Indian J. Pure Appl. Phys., 3: 170-2(May 1965).

The characteristics of a gas-phase counting system for the estimation of ^{14}C are described. The counter uses carbon dioxide and a commercial fuel gas as the counting and quenching gases at the partial pressures 6 and 24 cm, respectively. The sample to be assayed is converted into carbonate before its ^{14}C content is estimated by the system. The carbonate is treated with dilute nitric acid and the resultant carbon dioxide is dried and filled into a Geiger-Mueller counter for internal counting. The counter is calibrated and its linear response confirmed. Samples with a $^{14}C/^{12}C$ ratio as low as 1.567×10^{-10} can satisfactorily be assayed. This concentration of ^{14}C corresponds to 10^{-2} of the maximum permissible concentration level in air. (auth)

36284 ANALYSIS OF OXYGEN-18 IN CARBON DIOXIDE BY THERMAL NEUTRON ACTIVATION. Fritz, G. J.; Han, I.; Ellis, W. H. (Univ. of Florida, Gainesville). Intern. J. Appl. Radiation Isotopes, 16: 431-7(July 1965). (TID-21421)

A study was made of the thermal neutron activation analysis of ^{18}O in samples of carbon dioxide. The technique involved the precise measurement of small quantities of gaseous carbon dioxide and their transfer into polyethylene containers, followed by the conversion of the carbon dioxide to solid ammonium carbamate by addition of an excess of ammonia gas. After the ammonium carbamate was irradiated, it was flushed from the container with water, and the induced ^{19}O activity was measured. The minimum amount of ^{18}O which could be determined in carbon dioxide by this technique was estimated to be 0.5 μg. (auth)

36285 RAPID DETERMINATION OF ^{89}Sr AND Sr^{90} IN A MIXTURE. Lazzarini, E. (Centro Studi Nucleari E. Fermi, Milan). Intern. J. Appl. Radiation Isotopes, 16: 443-5(July 1965).

A rapid and accurate method for the determination of ^{89}Sr and ^{90}Sr in mixtures based on the separation of ^{90}Y, daughter of ^{90}Sr, from ^{90}Sr and ^{89}Sr by paper electrophoresis is discussed. (J.F.H.)

36286 A ROUTINE METHOD FOR DETERMINATION OF C^{14} BY LIQUID SCINTILLATION. Edwards, B.; Kitchener, J. A. (Imperial Coll., London). Intern. J. Appl. Radiation Isotopes, 16: 445-6(July 1965).

Organic materials labeled with ^{14}C were oxidized and the $^{14}CO_2$ collected in a scintillation counting chamber for determination of the ^{14}C activity. The efficiency of the method was tested by use of a standard sample of polymethylmethacrylate containing 1 μc/g ^{14}C. The absolute efficiency of counting ^{14}C by this procedure was about 40%. (F.J.H.)

36287 ADVANCES IN NEUTRON ACTIVATION ANALYSIS. Guinn, Vincent P. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Isotopes Radiation Technol., 2: No. 4, 329-39(Summer 1965).

A review is presented of improvements in activation analysis. The improvements discussed include equipment, techniques, and applications. A bibliography is included. (D.L.C.)

36288 DETERMINATION OF CERTAIN TRACE IMPURITIES IN PURE LEAD AND ALUMINUM BY ACTIVATION ANALYSIS. El-Shamy, H. K.; Abdel-Rassoul, A. A.; Bishay, T. Z. (Atomic Energy Establishment, Inshas, UAR and Ministry of Industry, Cairo, UAR.) Isotopes Radiation Technol., 2: No. 4, 348-9(Summer 1965).

An activation method is described for the determination of trace Cr, Co, Sn, Fe, Zn, and Cd in Pb and Al. After a 48-hr irradiation in a 1.3×10^{13} n/cm^2-sec flux and subsequent decay, the samples and standards are subjected to coprecipitation and ion exchange separations. Activity measurements are then carried out with a shielded G-M counter. (D.L.C.)

36289 A QUICK AND PRECISE HETEROMETRIC MICRODETERMINATION OF VANADIUM WITH 5,7-DIBROMO-8-HYDROXYQUINOLINE. Bobtelsky, M.; Gancz, M. (Hebrew Univ., Jerusalem). Israel J. Chem., 3: 29-32(Apr. 1965).

A heterometric study was made of the reaction between vanadium and 5,7-dibromo-8-hydroxyquinoline. A method is presented for the determination of 0.2 mg V^{5+} in 20 ml

aqueous solution, which can be carried out within 10 minutes. The analyzed solution may generally contain over 95 mol % Ca, Mg, Zn, Ni, Co, Cd, Cr, NaCl, NH_4NO_3, $(NH_4)_2SO_4$, citrate, arsenate, and tartrate, and over 70 mol % Al, Pb, U, Zr, and Th. The error was about 1%. (auth)

36290 SPECTROPHOTOMETRIC DETERMINATION OF CERIUM. Ganopol'skii, V. I.; Krivonozhnikova, L. G.; Shvarev, V. S. (A. M. Gor'kii Ural State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Khim. i Khim. Tekhnol., 6: 913-17(1963). (In Russian)

Descriptions are given of a spectrophotometric method of cerium determination in rare earth oxides and salts using the photoabsorption of cerium in pernitrilotriacetate complex in the ultraviolet at λ_{max} = 300 mμ. The maximum sensitivity of the pernitrilotriacetate method was 2.5×10^{-4}% cerium in the specimen. (R.V.J.)

36291 ACTIVATION ANALYSIS OF PHYSICAL EVIDENCE CONNECTED WITH ILLICIT DISTILLERIES. Pro, M. (Internal Revenue Service, Washington, D. C.); Schlesinger, H.; Cohan, M. J. Assoc. Offic. Agr. Chemists, 48: 459-71(June 1965).

Neutron-activation analysis has been employed to compare moonshine, soil, and paint collected as physical evidence during the investigation of illicit distilleries. These materials were irradiated in a DASA-TRIGA nuclear reactor and the induced radionuclides were identified by nondestructive gamma-ray spectrometry. The results obtained indicate the technique can be employed to compare these materials. The findings have been accepted for use in court as evidence. (auth)

36292 EXTRACTION OF AMERICIUM–CURIUM–EUROPIUM FROM LITHIUM CHLORIDE–HYDROCHLORIC ACID BY TERTIARY AMINES. Roth, John A. (Vanderbilt Univ., Nashville, Tenn.); Henry, Hugh E. J. Chem. Eng. Data, 10: 298-301(July 1965). (TID-21066)

Phase equilibrium data at 25°C for the system Adogen 364- or Alamine 336-hydrochloric acid with americium, curium, or europium were determined in the presence of lithium chloride, stannous chloride, and stannic chloride. The data were combined with data in the literature correlated, and expressed by a mathematical representation for use in analytical investigations of the process. (auth)

36293 SEPARATION OF YTTRIUM-90 FROM STRONTIUM-90 WITH AN ANION EXCHANGE RESIN IN BICARBONATE FORM AND STUDIES ON YTTRIUM BICARBONATE COMPLEX ION. Ogura, Tusgitoshi; Tarutani, Toshikazu; Misumi, Seizo (Kyushu Univ., Fukuoka, Japan). Mem. Fac. Sci. Kyushu Univ. Ser. C, 5: 129-32(1964).

A column (1 cm^2 x 10 cm) of Dowex-1, X-8 in bicarbonate form (50-100 mesh) was used to separate ^{90}Y from ^{90}Sr as follows. One ml of solution containing both radioisotopes was added to 50 ml of 0.2M potassium bicarbonate solution. After the solution was passed through the column, the resin bed was washed with 50 ml of distilled water. Then the radioisotope remaining in the resin bed was eluted with 50 ml of M hydrochloric acid at a flow rate of 0.8 ml/min. At the beginning of the elution the resin bed was disturbed by the release of carbon dioxide, but it gradually settled down and was packed uniformly again. This disturbance did not affect the separation of ^{90}Y from ^{90}Sr since only ^{90}Y was adsorbed on the resin bed. Strontium-90 passed through the resin bed and flowed out completely with 30 ml of distilled water, whereas ^{90}Y was firmly adsorbed on the resin bed and was not eluted with 50 ml of distilled water. The distribution of Y between resin and solution as a function of bicarbonate concentration was measured by equilibrium method over the concentration range of 0.2 to 0.6M. The results show that the amount of Y adsorbed on the resin decreases with increasing bicarbonate concentration. The slope of the curve of the distribution coefficients of Y as a function of bicarbonate concentration showed that the maximum slope obtained at the higher concentrations is −3. This corresponds to an average ligand number of 6 and indicates the presence of hexabicarbonate complex. (BBB)

36294 RADIOACTIVATION OF GALLIUM, INDIUM AND THALLIUM BY MEANS OF PHOTONUCLEAR REACTION AND THE DETERMINATION OF RESPECTIVE CONTENTS IN THEIR MIXTURES. Oka, Yoshinaga (Tohoku Univ., Sendai); Kato, Toyoaki; Sasaki, Michio. Nippon Kagaku Zasshi, 86: 612-19(June 1965). (In Japanese)

For the applications of the photonuclear reaction on non-destructive determinations of Ga, In, and Tl in their mixtures, a linear accelerator operated with a maximum energy of 20 Mev was used. The individual metals or the synthetic mixtures of Ga–In, Ga–Tl, and In–Tl in different mixing ratio were bombarded for 3 hr with the bremsstrahlung (20 Mev, about 5×10^6 roentgens/min). The radioactivity strengths of ^{68}Ga, ^{114m}In, and ^{202}Tl produced by (γ,n) reaction were sufficient for determining contents. In each system, the matrix element was employed as an internal monitor of bremsstrahlung flux to which the sample was exposed. For instance, when various mixtures of Ga–In were photoactivated by the same condition as described above, a linear relationship was obtained between the ratios of the photoelectric peak intensities at a time of the end of bombardment, $R_{A_y} = {}^{68}Ga$ (cpm at 0.511 Mev)/^{114m}In (cpm at 0.190 Mev), and the ratios of the weights, $R_W = W_{Ga}/W_{In}$; hence, using the relationship it was possible to determine the Ga concentration in sample of In and the determination limit was about 200 ppm. In the other system, a proportionality was also obtained between R_{A_y} and R_W by a similar treatment, and the experimental condition for the determination of the respective contents are described in detail. (auth)

36295 ACTIVATION ANALYSIS OF TANTALUM IN NIOBIUM BY PHOTONUCLEAR REACTION. Abe, Shigeki (Yamagata Univ., Motonakabakurocho, Japan). Nippon Kagaku Zasshi, 86: 641-3(June 1965). (In Japanese)

A nondestructive activation analysis of tantalum in niobium by the photonuclear reaction was investigated. Tantalum and niobium were irradiated for one hour with a 20 Mev bremsstrahlung generated from the linear accelerator. The induced radioactivities of ^{180m}Ta and ^{92}Nb, produced by the (γ,n) reactions, were measured by γ spectrometry. In the γ spectrum of ^{180m}Ta, an intense photopeak at 0.06 Mev and a weak one at about 0.1 Mev, decayed together with the half life of 8.2 hrs., were found. ^{92}Nb had a photopeak at 0.93 Mev and decayed with the half life of 10.1 days. For the quantitative analyses, it is possible to use the linear relationship between the photopeak activity ratio of $^{180m}Ta/^{92}Nb$ and the weight ratio of Ta/Nb. As an experimental result, about 0.076% of tantalum was found in a niobium sample used. (auth)

36296 CHEMICAL STUDIES ON MINERALS CONTAINING RARER ELEMENTS FROM THE FAR EAST DISTRICT. LVIII. A VARIETY OF ZIRCON FROM ORO, KYOTO PREFECTURE, JAPAN. Fujiwara, Shizuo (Tokyo Univ.); Nagashima, Kozo; Chiba, Morito. Nippon Kagaku Zasshi, 86: 646-7(June 1965). (In Japanese)

Chemical and x-ray analysis and electron probe x-ray microanalysis on one variety of zircon of dark brown color and specific gravity of 4.19, were performed. The x-ray powder patterns coincided with those of the usual variety of zircon. The results of the chemical analysis were: SiO_2 26.71%, P_2O_5 2.63, Al_2O_3 0.58, $(Nb, Ta)_2O_5$ 0.12, TiO_2 0.08, $(Zr, Hf)O_2$ 51.64, Fe_2O_3 2.93, UO_2 1.84, ThO_2 1.46, ΣY_2O_3 7.47, CaO 0.59, MgO 0.12, MnO 0.02, H_2O (+) 3.34, H_2O (−) 0.34, total 99.87%. The chemical characteristic of the zircon is a higher concentration of phosphorus and rare earths. The experimental formula calculated from the analysis is $(Zr, Y, Fe)_{0.96}(Si, P, Al)_{0.96}(O_{3.33}(OH)_{0.67})_{4.00}$. The distribution of rare earths in the mineral was determined by x-ray fluorescence analysis and was found to be of the so called xenotime type. Examination of a polished surface of the mineral by the x-ray microanalyser indicated the presence of very small (50 ~ 60 microns in diameter) crystals of xenotime, suggesting the solubility limit of xenotime in zircon under the geochemical condition of the present locality. (auth)

36297 PHOTOMETRIC DETERMINATION OF Ce AND Mn IN METALLIC NICKEL BY TBP EXTRACTION. Fuke, Yoshitaro; Nakamura, Isao (Tokushu Denkyoku Co., Ltd., Amagasaki, Japan). Nippon Kinzoku Gakkaishi, 29: 283-6 (1965). (In Japanese)

The conditions needed for the photometric determination of Ce and Mn in Ni by solvent extraction using TBP are given. Ce in metallic nickel could be completely extracted and isolated from 8N HNO_3 by repeating the process of extraction and isolation twice using TBP. By back-extracting this extraction phase using the 8N HNO_3 solution containing 3% H_2O_2, the photometric determination of Ce could be successfully carried out at 320 mμ by the $AgNO_3-K_2S_2O_8$ method, while, similarly, the photometric determination of Mn could be undertaken at 530 mμ from the residual solution by the $AgNO_3-(NH_4)_2S_2O_8$ method. The range of determination of Ce by this method was 0.01 to 0.30%, and such coexisting elements as Fe and Si, in metallic nickel were not generally seen to exert any influence. (auth)

36298 COMPARABILITY AND EFFECTIVENESS OF URANOMETRIC GEOCHEMICAL SURVEYS IN DETERMINATION OF URANIUM BY CHEMICAL AND α-RADIATION METHODS AND COMPARING THEM WITH RADIOMETRICAL Γ SURVEY. Depciuch, T.; Lis, J.; Przenioslo, S.; Sylwestrzak, H. Przeglad Geol., 13: 158-62(Apr. 1965). (In Polish)

Determinations of uranium were made by chemical (luminescence) methods and by α measurement methods during uranometric geochemical alluvial and soil surveys. A very good correlation was found to exist between the results of both methods applied in the soil survey. However, a low correlation was observed in the alluvial survey. The area investigated showed that by means of α measurement methods only 28% of the anomalous samples were detected. Measurement of γ radiation in sampling site allowed detection of only 12% of the anomalous samples. When comparing the chemically determined uranium contents with the values of uranium equivalent (eU) investigated by measurement of γ radiation, a displacement of radioactive equilibrium toward radium was observed. In spite of some interdependences between the results of both methods, it was concluded that the eU-measurement method should not be used in geochemical surveys, mainly because of radioactive equilibrium oscillation and degrees of displacement. (auth)

36299 DETERMINATIONS OF BORON IN BOROSILICATE GLASS AND FRIT BY NEUTRON ABSORPTIOMETRY. Wada, Nobuo (Nagoya Municipal Industrial Research Inst., Japan); Enomoto, Shigemasa. Radioisotopes (Tokyo), 14: 212-17(May 1965).

Neutron absorptiometry for determining of boron contents in borosilicate glass and frit was investigated. A Ra + Be (4.81 mg Ra) fast neutron source was used and paraffin was used to slow down the fast neutrons to thermal velocity. The neutron detector was a ZnS(Ag)-B polyester scintillator 2 in. in dia and $\frac{5}{8}$ in. thick. The relations between the intensity of slow neutrons produced and the size of paraffin was studied, and then a neutron source arrangement suitable for neutron absorption analysis was prepared. Measurements were made of neutron transmittance of borosilicate glasses and frits of known boron content. The accuracy of boron determination was highest in the case of $\sigma nx = 2$, where σ was the cross section per atom, n was the number of atoms in cm^3, and x was the thickness of sample material to be tested. The relative error of boron determination was estimated as about ±9% in 10 min counting for a sample when B_2O_3 content was 5% for frit sample of 1.75 g/cm^2 thickness. (auth)

36300 DIRECT RADIOACTIVE ASSAY OF CATION RETENTION BY MINERAL AND ORGANIC COLLOIDS. Wells, B. R.; Graham, E. R. (Univ. of Missouri). Soil Sci., 100: 10-13(July 1965). (TID-21708)

The direct measurement of cations retained by clay revealed that reproducible results are obtainable with the direct methods. A sensitivity of ±1 me/100 g is possible with mg quantities of clay. The results obtained with kaolin clay when sodium and cesium were the saturating ions indicated that the attraction by kaolin for Na and Cs was lower than that observed for the other systems. The illite clay revealed no measurable differences in the retention of Na and Cs with change in pH. The differences observed with Sr and Zn were slight. Zinc was adsorbed by all colloidal systems even in the presence of high hydrogen saturation. To obtain reproducible results for the cation-exchange capacity, the control of the suspension pH and use of a strontium salt containing ^{85}Sr is suggested. (auth)

36301 TREATISE ON ANALYTICAL CHEMISTRY. PART II. ANALYTICAL CHEMISTRY OF THE ELEMENTS. SECTION A. SYSTEMATIC ANALYTICAL CHEMISTRY OF THE ELEMENTS. VOLUME 6. BERYLLIUM · LEAD · NIOBIUM AND TANTALUM · TECHNETIUM · ACTINIUM, ASTATINE, FRANCIUM, POLONIUM, AND PROTACTINIUM. Kolthoff, I. M.; Elving, Philip J.; Sandell, Ernest B. (eds.). Treatise Anal. Chem., Pt. II, 6: 1-627(1964). New York, Interscience Publishers. $23.00.

Analytical data on beryllium, lead, niobium, tantalum, technetium, actinium, astatine, francium, polonium, and protactinium are presented. Separate abstracts were prepared for each of the 5 chapters. (F.J.H.)

For abstracts of individual chapters see: 36302, 36303, 36304, 36305, and 36306.

36302 BERYLLIUM. Kjellgren, B. R. F.; Schwenzfeier, C. W., Jr.; Melick, E. Stanley (Brush Beryllium Co., Elmore, Ohio). Treatise Anal. Chem., Pt. II, 6: 1-67(1964).

Analytical data on industrial processes, toxicology, industrial products and uses, beryllium compounds, properties, sampling, separation and isolation of beryllium, detection and isolation, quantitative determination, and recommended laboratory procedures are presented. Nuclear properties of beryllium are discussed. It is reluctant to acquire additional neutrons but is willing to part with one of its neutrons. It has an extremely low thermal absorption cross section and is an excellent scatterer and moderator of neutrons. When beryllium, in its normal state, was subjected to irradiation by gamma rays at an energy level in excess of 1.63 Mev, neutrons were liberated. Beryllium is an excellent source of neutrons when bombarded by γ particles, deuterons, or protons. The nuclear reaction $^9Be(\gamma,n)^8Be$, using ^{124}Sb as the gamma source (76% have an energy level above 1.63 Mev, the threshold for ^9Be), was utilized for the qualitative and quantitative determination of beryllium in ore, and was proposed as a method of "picking" beryl. By counting the photo neutrons resulting from the nuclear reaction $^9Be(\gamma,n)^8Be$, a quantitative as well as a qualitative estimate of the beryllium content of an ore was possible. (F.J.H.)

36303 LEAD. Gilbert, T. W., Jr. (Univ. of Cincinnati). Treatise Anal. Chem., Pt. II, 6: 69-175(1964).

Properties of lead and its compounds, separation and isolation of lead, detection and identification of lead, determination, determination of lead in specific materials, and recommended laboratory procedures are discussed. Lead obtained from thorium-rich minerals was found to an atomic weight greater than that of ordinary lead (obtained from galeno), whereas the atomic weight of lead from uranium-rich minerals was lower. Since the absorption of x rays increases rapidly with increasing atomic number of the absorber, lead was readily determined in media containing elements of low atomic number. Lead has such a low activation cross section that methods of activation analysis were developed for the determination of traces of lead in meteorites. (F.J.H.)

36304 NIOBIUM AND TANTALUM. Kallmann, Silve (Ledoux and Co., Inc., Teaneck, N. J.). Treatise Anal. Chem., Pt. II, 6: 177-406(1964).

Properties of niobium and tantalum, sampling of niobium and tantalum, separation and isolation of niobium and tantalum from other elements, separation of niobium and tantalum, detection and identification, determination of niobium

and tantalum, analysis of niobium and tantalum metals, alloys, and compounds, and selected laboratory procedures are discussed. ^{94}Nb and ^{182}Ta are of analytical importance for the determination of the two elements by activation analysis. Uranium-base alloys, containing niobium, usually were dissolved in nitric acid plus hydrochloric acid. A mixture of hydrochloric acid and hydrogen peroxide was also used, but it was less effective than hydrofluoric acid-nitric acid combinations. Niobium can be determined in sulfuric acid medium photometrically by measuring the absorbance of a solution of the complex formed with hydrogen peroxide at 360 mμ and cancelling out the interference of uranium by using a portion of the sample solution as a reference. X-ray emission spectroscopy is considered an excellent tool for the determination of small amounts of niobium and tantalum. The intensity of the niobium radiation, in the case of spectroscopy, was considerably greater than that of the tantalum. Tests indicated that it was possible to detect, in a matrix of light elements such as silicate rock, 0.01% niobium and about 0.05% tantalum. The effects of other elements on x-ray spectroscopy when used for the quantitative determination of niobium and tantalum were studied. Niobium and tantalum were determined using the following methods: electron probe measurements for niobium compounds only, radioactive tracers, isotope dilution procedures, neutron-activation analysis, radiochemical separations involving ^{95}Nb, and other radiochemical procedures. Determination of interstitial elements in niobium and tantalum by neutron activation, and by isotopic dilution is discussed. Determination of metallic impurities in niobium and tantalum by x-ray fluorescence procedures, and radioactivation for trace elements in niobium are discussed. (F.J.H.)

36305 TECHNETIUM. Cobble, James W. (Purdue Univ., Lafayette, Ind.). Treatise Anal. Chem., Pt. II, 6: 407-34(1964).

Properties, separation and isolation, detection and identification, toxicology and industrial hygiene, determination of technetium, and recommended laboratory procedures are described. The fission-product ^{99}Tc, undoubtedly, exists on the earth as a result of nuclear detonations and from spontaneous and natural neutron-induced fission of uranium and thorium. ^{99}Tc is the only technetium isotope encountered in weighable amounts, and it can be separated from the fission products or made from neutron bombardment of molybdenum: $^{98}Mo(n,\gamma)^{99}Mo \xrightarrow{\beta-} {}^{99}Tc$. The largest amounts of technetium are produced from the fission of uranium and are found in the so-called waste products. It can be separated from most other fission products and actinide elements by certain solvent-extraction, ion exchange, precipitation, and volatilization procedures. (F.J.H.)

36306 ACTINIUM, ASTATINE, FRANCIUM, POLONIUM, AND PROTACTINIUM. Sedlet, Jacob (Argonne National Lab., Ill.). Treatise Anal. Chem., Pt. II, 6: 435-610(1964).

Analytical data on actinium (atomic number 89), astatine (atomic number 85), francium (atomic number 87), polonium (atomic number 84), and protactinum (atomic number 91) are presented. All isotopes of the elements are radioactive, and this nuclear instability greatly affects the choice of techniques and procedures used in their determination. Isotopes of the elements occur in nature only as members of radioactive decay series. (F.J.H.)

36307 PREPARATION OF ISOTOPIC FOILS FROM YTTERBIUM OXIDE. Karev, V. M.; Klyucharev, O. P.; Lisbenko, L. H.; Nazarova, T. S. (Inst. of Physics and Tech., Moscow). Ukr. Fiz. Zh., 10: 692-3(June 1965). (In Ukrainian)

Experiments were performed to develop an efficient method for obtaining pure isotopic ytterbium foil by reduction of ytterbium oxide (Yb_2O_3) by La, Ca, Be, Ti, and Zr in vacuum. A mixture of ground Yb_2O_3 and La (the latter taken with a 100% excess over the theoretical amount) was placed in a molybdenum crucible with a tantalum lining and degassed in a vacuum varied from 1×10^{-5} to $(2-4) \times 10^{-4}$ mm Hg. The reduction of Yb_2O_3 proceeded at 1000 to 1200°C; the foils deposited on stainless-steel, molybdenum, or tantalum substrates contained 1 to 2% La. Reduction with Ca and Be was unsatisfactory because of the higher reduction temperatures required and because of contamination, which made the foils brittle. Reduction of Yb_2O_3 by 99.99% pure Ti or Zr gave the best results. The reduction proceeded at lower temperatures (850 and 1000°C) than the reduction with La, and the obtained foils contained only an insignificant amount of Ti and no Zr. The ratio of the components in the charge had a great bearing on the yield of metallic Yb. In reduction of Yb_2O_3 with Zr, a maximum yield of Yb was obtained with the 1:2 ratio. Isotopic Yb foils, 3 to 4 μ thick, which did not deteriorate with storing in air, were readily obtained by the reduction of 100 mg of Yb_2O_3 with zirconium powder. (ATD)

36308 APPLICATIONS OF ION EXCHANGE CHROMATOGRAPHY FOR STUDYING THE ION STATE IN HIGH-VALENCY ELEMENTS IN SOLUTIONS. Nabivanets, B. I. (Inst. of General and Inorganic Chemistry, Kiev). Usp. Khim., 34: 949-67(May 1965). (In Russian)

As a result of their high ionic potential, polyvalent elements cannot exist in the free state in aqueous solutions because they tend to undergo hydrolysis, form complex compounds with various ligands, or polymerize. The problems thus posed may be resolved by means of ion-exchange chromatography, which makes it possible to determine the sign, charge, degree of hydrolysis, polymerization factor, composition, and stability of the complexes formed. The specific properties of the exchange resins, such as the equivalent exchange capacity, swelling, and the diffusion kinetics of the exchange process make it feasible to determine directly, in a single experiment the ionic charge. The method and the underlying theoretical principles are described, using the determination of the properties of some typical ions, such as Ti(IV), Zr(IV), Mo(VI), Nb(V), TiO_2^{2+}, $Zr_x^{(4-x)}$, NbO_2^+, Ru, etc., as examples. 72 references are included. (TTT)

36309 PHOTOMETRIC DETERMINATION OF THORIUM IN NATURAL WATERS USING ARSENAZO III. Akselrod, F. M.; Lyalikov, Yu. S. (Moldavian Scientific-Research Inst. of Hygiene and Epidemiology, Kishinev, USSR). Zh. Analit. Khim., 20: 514-16(1965). (In Russian)

A photometric method was suggested for Th determination in natural waters. The method uses arsenazo III. (trauth)

36310 ON INSTRUMENTAL ERRORS IN THE PRECISION DETERMINATION OF THE ISOTOPIC COMPOSITION OF ELEMENTS. Galimov, E. M.; Grinenko, V. A.; Ustinov, V. I. (Inst. of Petroleum Chemistry and Gas Industry, Moscow and Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Analit. Khim., 20: 547-53(1965). (In Russian)

Two types of errors are discussed. The errors of the first group were caused by accidental fluctuations of the mass spectrometer characteristics. These errors were estimated by means of statistics. The errors of the second group occurred due to the variation of conditions when measurements were carried out at different times, fluctuations of the temperature, humidity, background conditions, zero drift, etc. By means of formulas obtained analyses of experimental errors were made, and the results were given in two tables. The errors considered have a decisive influence on the reproducibility of the isotopic analysis. (auth)

36311 FLAME-PHOTOMETRIC DETERMINATION OF GADOLINIUM AND YTTRIUM USING THE APPARATUS OF HIGHER DISPERSION. Ovchar, L. A.; Vitkin, R. A.; Poluektov, N. S. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Analit. Khim., 20: 554-60(1965). (In Russian)

Conditions were studied for using a spectrograph with a photoelectric attachment, with a higher resolving power than that of flame spectrophotometers used before for determining gadolinium and yttrium. The sensitivity of gad-

olinium determination by the molecular band with a maximum at 461.5 mμ was 0.25% and that for yttrium at 597.2 mμ was 0.05 to 0.1% in a mixture of rare earth oxides. Certain characteristic phenomena observed by the flame-photometric determination of rare earths were studied (disproportionally small radiation intensity at small concentrations and the increase in the radiation intensity in the presence of other rare earths). A method was developed for determining gadolinium and yttrium in rare earth oxides. (auth)

36312 A STUDY OF THE REACTION OF THORIUM IONS WITH METHYLTHYMOL BLUE. Vasilenko, V. D.; Shanya, M. V. (Dnepropetrovsk State Univ., USSR). Zh. Analit. Khim., 20: 636-8(1965). (In Russian)

The maximum absorption of thorium—methylthymol blue complex was at 580 mμ. The components interacted at the molar ratio of 1 : 2. The molar extinction coefficient at λ = 580 mμ was 50,000. It was shown that methylthymol blue can be used for the photometric determination of thorium in the presence of uranium. The relative experimental error was not more than 5%. The probable deviation of a single determination was not more than 3%. (auth)

36313 ELEMENT TRACES INVESTIGATIONS IN WATERS OF LAKE YPACARAI. [PART] I. Facetti, J. F.; Facetti, F. (Comision Nacional de Energia Atomica del Paraguay, Asuncion). pp 105-7 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

The presence of iodine in lake water was studied by means of neutron activation. The iodine content found agrees with the idea that that element is incorporated into the exogenous cycle from igneous rocks, and confirms the results obtained by other investigators of Japanese lake waters. The activation method proved to be rapid and efficient. (auth)

36314 TRACE ELEMENT ANALYSES OF SOME MARINE ORGANISMS. Stevenson, Robert A.; Ufret, Sara Lugo; Diecidue, Alfonso Tom (Puerto Rico Nuclear Center, Mayaguez). pp 233-9 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

Levels of certain trace elements were determined in a number of benthic marine plants and animals. Levels of Sc were determined by activation analysis and Fe, Ni, Mn, and Cr were determined by atomic absorption spectroscopy. Concentration factors in the organisms are related to the concentration of the elements as reported for sea water. Possible accumulation of radioactive isotopes of these elements by marine animals and plants in the area is discussed in relation to cooling water from a nuclear power plant at Punta Higuero, Puerto Rico. (auth)

36315 INVESTIGATIONS OF TRACE ELEMENT DISTRIBUTION IN MARINE WATERS AND SEDIMENTS. Lowman, F. G.; Quinones, L.; Miro, M.; Oliver de Padovani, I.; Ramos, E.; Roman de Vega, V.; Bielen, H. J. (Puerto Rico Nuclear Center, Mayaguez). pp 241-59 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

The distributions of Sc, Cr, Mn, Fe, Ni, Zn, Mg, Ca, and Sr in marine waters and sediment cores were determined in an area offshore from the outflow of a major river in Puerto Rico. The distributions of these elements in the marine waters and sediments are discussed in relation to the dissolved, colloidal, and particulate material supplied by the river, the chemical interaction of the introduced elements with sea water, and the influence of the predominant inshore water currents upon the movements of the water masses in that area. (auth)

36316 APPLICATION OF RADIOELEMENTS TO INVESTIGATING THE PURIFICATION OF METALS BY THE ZONE REFINING METHOD. SYSTEMATIC ANALYSIS AFTER IRRADIATION WITH NEUTRONS. Albert, Philippe. (Metallurgical Chemical Research Center, Vitry, France). p.1-51 of "New Physical and Chemical Properties of Metals of Very High Purity." New York, Gordon and Breach Science Publishers, 1965.

The techniques and advantages of using radioelements for the identification of trace elements and their distributions in metals purified by the zone refining method are discussed. A high degree of sensitivity exists for 40 to 45 elements and it is possible to measure their presence in a sampling of the order of 1 g. The risk of contamination by reagents and vessels used in chemical separations is avoided as the radioelements are introduced by irradiation. The application of these methods to aluminum and iron is discussed. (W.L.G.)

36317 COLORIMETRIC DETERMINATION OF ELEMENTS. Principals and Methods. Charlot, G. Translation by Express Translation Service of Dosages Colorimetriques des Elements Mineraux. Principes et Methods. New York, [American] Elsevier Publishing Company, Inc., 1964. 456p. $18.00.

Theoretical data are given under the following headings: Beer's Law and additivity of optical densities; principles of operation and equipment; accuracy and precision of colorimetric estimations; experimental procedures in colorimetric estimations; fluorimetry, turbidimetry, and nephelometry; photometric and spectrophotometric titrations; separation of trace amounts; separation by extraction; separation by ion exchange; separation of similar substances; chromatography; separations in the gaseous state; and electrolytic separations. Methods for estimation of the principal elements are presented and discussed. (F.J.H.)

36318 METHODES D'ANALYSE—CETAMA—1962. METHODES 1 a 100. [RECUEIL No. 1]. (Methods of Analysis—CETEMA, 1962. Methods 1 Through 100. [Collection No. 1]). Paris, Presses Universitaires de France, 1962.

One hundred analytical methods used in the CEA laboratories were compiled. The range of applicability, the principles, the apparatus used, the reagents, and the procedures used are given for each method. (M.C.G.)

36319 METHODES D'ANALYSES—CETAMA—1964. METHODES 101 a 150. [RECUEIL No. 2]. (Methods of Analysis—CETEMA, 1964. Methods 101 through 150. [Collection No. 2]). Paris, Presses Universitaires de France, [1964].

Fifty analytical methods used in the CEA laboratories were compiled. The range of applicability, the principles the apparatus used, the reagents, and the procedures are given for each method. (M.C.G.)

36320 (STI/PUB/88(Vol.II)) RADIOCHEMICAL METHODS OF ANALYSIS. Proceedings of the Symposium Held at Salzburg, 19-23 October, 1964. Proceedings Series. (International Atomic Energy Agency, Vienna). Feb. 1965. 532p. (CONF-641001(Vol.II)). $11.00; S 231,-; £3.60; F.Fr. 44,-; DM 38,50(IAEA).

A total of 35 papers is presented, arranged under the following headings: radioactivation analysis, analytical applications of radioactive tracers, and analytical applications of radioactive sources. Separate abstracts were prepared for four papers that were not previously abstracted in NSA. For abstracts of the others, see NSA 18: 41314, 43372, and 43386; 19: 5815, 5816, 5818, 5819, 5821, 5823, 5825, 5826, 5828, 5831, 5835, 5837, 6001, 6207, 6238, 7333, 7334, 7335, 7338, 7342, 7343, 7344, 7346, 7348, 7350, 9434, 9561, and 20322. (D.L.C.)

For abstracts of individual papers see: 36321, 36322, 36323, and 36324.

36321 COBALT ACTIVATION IN THE CENTIGAMMAS RANGE. IN THE PRESENCE OF MILLIGRAM AMOUNTS OF IRON, FOR BIOLOGICAL ASSAY. Maxia, V.; Meloni, S.; Rollier, M. R.; Valenti, M. T. (Universita, Pavia, Italy). pp 25-32 of STI/PUB/88(Vol.II).

A method of cobalt detection and determination in the presence of iron by neutron activation is presented. Both cobalt and iron are irradiated in the form of organic compounds to simulate a biological specimen. In samples of

constant iron content (5 mg) the amount of cobalt is changed, starting from 0.08 μm down to the minimum detectable amount. After irradiation, cobalt and iron are separated by ion exchange and mounted for gamma spectrometry. The separation technique has been previously tested using ^{60}Co and ^{59}Fe solutions. Accuracy of the tests, sensibility, and reliability of the method are reported and discussed. (auth)

36322 NON-DESTRUCTIVE ACTIVATION ANALYSIS BASED ON PHOTONEUTRON COUNTING. Amiel, S. (Atomic Energy Commission, Yavne, Israel). pp 101-10 of STI/PUB/88(Vol.II).

The measurement of a specific gamma ray of relatively high energy in a radioactive matrix is usually done with a scintillation spectrometer connected to an electronic discriminator. When unwanted gamma rays of higher energy are present, the scintillator is connected to a single or a multichannel pulse height analyser. In favorable instances, coincidence counting is used. When the energetic gamma ray in question is a minor or trace constituent of the gross activity of a highly active sample, it is usually masked by the tail and sum-peaks of the much more intense low-energy gamma rays. An electronic bias or even pulse height analysis is then ineffective. Moreover, the high intensity of the background activity might cause overloading of the detector and paralyze it for a considerable fraction of the counting time. One solution is to use chemical purification, but this is frequently undesirable, and sometimes difficult or practically impossible due to the short half life of the radioactivity in question. The present method utilizes the well-known property of beryllium and deuterium to emit neutrons upon interaction with gamma rays of energies higher than the photo-disintegration threshold. This threshold is 1.67 Mev for beryllium and 2.23 Mev for deuterium, so that lower-energy gamma rays are discriminated against. The number of reactor-produced radionuclides which emit gamma rays of energy greater than 1.67 or 2.23 Mev is relatively small. The number is further reduced when only a specific half-life range is considered. The high degree of selectivity obtained thus makes photoneutron counting very useful in activation analysis. The apparatus used in the present work consists of a beryllium box, or a D_2O container, at the center of which the irradiated sample is placed. The box is surrounded by a ring of $^{10}BF_3$ neutron detectors embedded in a paraffin block. The pulses from the detectors are amplified and registered on a recording scaler. The determination by photoneutron counting of aluminium, sulphur, calcium, sodium, manganese, and other elements was studied in detail. In all cases the photoneutron activity was found to be proportional to the content of radionuclide emitting the high-energy gamma ray. The precisions obtained were 1 to 2% and the sensitivities were in the range 1 to 100 μg. The different aspects, potentialities, and possible interferences in this method of analysis are discussed in detail. (auth)

36323 ENHANCEMENT OF NEUTRON ACTIVATION ANALYSIS SENSITIVITIES BY USE OF REACTOR PULSES: EXPERIMENTAL RESULTS FOR 13 ELEMENTS. Yule, H. P.; Guinn, V. P. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 111-22 of STI/PUB/88(Vol.II).

The pulsing of the TRIGA Mark I reactor is expected to give a ratio of pulse-induced activity to saturation steady-operation activity $R = 54/T_{\frac{1}{2}}$, where $T_{\frac{1}{2}}$ = half life of the induced species. This relationship was investigated experimentally for 13 elements (O, F, Na, Mg, S, Sc, As, Se, Y, Tb, W, Pt, Au) that form neutron-induced activities with half lives of less than 1 min. The results confirm the relationship but give a slightly different equation, $R = 70 \pm 20/T_{\frac{1}{2}}$. (D.L.C.)

36324 ANALYSIS OF URANIUM SOLUTIONS BY SCINTILLATION DETECTION OF X-RAY FLUORESCENCE EXCITED BY Co^{57} 122-kev γ-RAYS. Forberg, S.; de Ruvo, A. R. (Royal Inst. of Tech., Stockholm). pp. 485-501 of STI/PUB/88(Vol. II).

^{57}Co is proposed as a radioactive source for quantitative x-ray fluorescence analysis of uranium in solutions. The choice of ^{57}Co is motivated by its suitable γ-ray energy, 122 kev, the absorption edge of uranium being 115.6 Mev; by the almost complete absence of disturbing radiations (7% of 136-kev γ rays); by the availability of high specific activity sources; and by its tolerable decay rate ($T_{\frac{1}{2}}$ = 267 day), permitting a practical life of one year or more for each source. A source of 1.6-mm dia, containing 2 mC of ^{57}Co was used for the studies discussed. The source was equipped with a small collimator and a radiation shielding made from alloyed tungsten. A NaI(Tl) crystal was used as a detector because of its high measuring efficiency. One drawback of such a detector is the fair energy resolution obtainable, which in fact limits the possibility of detecting x rays above the Compton distribution in the case of low concentrations. Studies were made to take advantage of the fact that the Compton-scattered secondary γ rays are, unlike x rays, non-isotropic both in energy and in intensity. By proper choice of the geometric arrangement of the source, sample, and detector, a geometric discrimination of the Compton scattering was possible. The detector was in fact constructed as a through-hole, two-crystal assembly with two opposite photomultiplier tubes, so that a relatively high energy resolution and a high degree of freedom with respect to the geometric arrangement was obtained. The pulses from the detector were analysed in an Intertechnique multichannel analyser. Typical spectra for selected geometric arrangements are shown, and the capability of this method of uranium analysis was elucidated for streaming solutions as well as for stationary samples. Mention is made of the interference from other elements. (auth)

36325 IMPROVEMENTS IN RADIOMETRIC ANALYSIS. Peter Edward Starnes. (to Hilger and Watts Ltd.). British Patent 990,920. May 5, 1965. Filed June 12, 1962.

In a method of testing powdered sample material by radiometric analysis, the powdered material is fed continuously onto a moving sample carrier. The feed rate is controlled by a weighing arrangement designed to form on the carrier a compacted layer of known and substantially constant mass per unit area and substantially constant depth. The sample is then moved by the carrier past a radiation source at a constant distance, and the resultant radiations emanating from the sample are measured. Apparatus is also provided for removing the compacted material from the carrier after measurement. (A.G.W.)

36326 APPARATUS FOR DETECTING AND ANALYSING LOW GASEOUS CONCENTRATIONS. Lovelock, James Ephraim (to National Research Development Corp.). U. S. Patent 3,176,135. Mar. 30, 1965. Priority date Jan. 26, 1960, Great Britain.

An apparatus is described for detecting and measuring small concentrations of gaseous substances in which the substances are introduced in low concentrations into an atmosphere of a rare gas acting as a carrier having an excitation potential not less than the ionization potential of the substances and being substantially free of impurities of lower excitation potential. The body of the apparatus has a cavity open at one end with a closure member to close the opening and form a cavity. A cathodic electrode connected to a source of potential and an inlet for a scavenging gas are located at the bottom of the cavity. Outlets for the scavenging gas are located in the closure member. A metal tube connected to a source of potential projects through the closure member into the chamber to act as an inlet for the carrier gas and substances and to serve as the anodic electrode. A source of radioactive particles in the chamber in electrical connection with the cathode produces free electrons by collision with gas atoms in the chamber. The electric field between the anode and cathode accelerates the electrons to an energy level sufficient to excite the atoms of the rare gas to a metastable state. The molecules of the substance are ionized by collision with the metastable atoms, and a third electrode supported in the closure member and insulated from the other electrodes collects the ionization potential. A fourth electrode located between the anode and cathode and maintained at a

positive potential with respect to the third electrode modifies the distribution of the electric field. (B.L.M.)

36327 METHOD AND APPARATUS FOR RADIOACTIVE GAS ANALYSIS USING NEUTRONS OF TWO ENERGY LEVELS. Booth, R. T. (to U. S. Atomic Energy Commission). U. S. Patent 3,201,586. Aug. 17, 1965.

A method and apparatus are described for determining the relative abundance of ^{235}U and ^{238}U in gaseous UF_6. A test sample is bombarded in an ionization chamber with high energy neutrons and then with thermal neutrons. The pulses so produced are compared with pulses obtained from a standard sample, and the relative abundance of the uranium isotopes in the sample is calculated. (AEC)

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Refer also to abstract 38064.

36328 (AD-607805) CHARGE DEPENDENCE IN IONIC SOLVATION. Technical Report No. 12. Golden, Sidney; Guttman, Charles (Brandeis Univ., Waltham, Mass. Dept. of Chemistry). Oct. 15, 1964. Contract Nonr-1677(01). 34p. $2.00(CFSTI)

Systems consisting of a single electrically neutral or ionic species in interaction with a large number of solvent molecules are treated in general quantum statistical mechanical terms. Such systems are assumed to have Hamiltonians, for each electronic state, which exhibit a dependence upon charge not exceeding quadratic. Changes in the Helmholtz free-energy, energy, and entropy functions are determined formally for the process of ionic solvation due to Born. On the basis of a general argument that an electrically neutral species acquires a non-zero potential upon solvation, the changes in the cited thermodynamic functions are shown to be capable of taking on positive values. This behavior is in direct contrast with expectations from the Born expression for such changes. Semi-empirical treatment of data available for solvation free-energies of aqueous ions permits an estimate, of one volt, to be made of this potential. A possible experimental test of this result is described. (auth)

36329 (AD-610494) OXIDATION OF TANTALUM IN CARBON DIOXIDE AND CARBON MONOXIDE. Saegusa, Fumihiko (Watervliet Arsenal, N. Y.). Sept. 1964. 34p. (WVT-6416). CFSTI, $2.00 cy, $0.50 mn.

The oxidation behavior of tantalum in carbon dioxide and carbon monoxide was investigated in the temperature range of 500 to 700°C. The rate of reaction was determined by measuring a change in electrical resistance of the specimen. The phase and structure changes were examined by using x-ray diffraction and metallographic techniques. The reaction involved solution of dissociated oxygen and formation of oxides, TaO_y, TaO_2, and Ta_2O_5. The initial parabolic oxidation by carbon dioxide was represented by the dissolution of oxygen and the subsequent linear oxidation was controlled by a phase boundary reaction. The parabolic oxidation by carbon monoxide was mainly associated with the dissolution of dissociated oxygen. (auth)

36330 (EUR-2249.e) OXYGEN AND HYDROGEN ELECTRODES IN MOLTEN FLUORIDES. Pizzini, S.; Morlotti, R.; Sternheim, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1965. 22p. (CONF-742-4) Dep. mn.

From 15th CITCE Meeting (Internat'l Comm. on Thermodynamics and Electrochemical Kinetics), London, England, Sept. 1964.

Overvoltage measurements in the molten LiF–NaF–KF eutectic mixture, containing oxides, hydroxides, and water in solution, were carried out by the galvanostatic single-pulse method in order to investigate the oxygen and hydrogen evolution reactions. Experiments were performed at 600°C on bright platinum electrodes with suitable oxygen or hydrogen electrodes as reference electrode. Results account for the high values of solubility of water and hydrofluoric acid in molten alkali fluorides and give some insight into the kinetics of the oxygen and hydrogen electrode reactions. (auth)

36331 (IA-1009) MOLAL OSMOTIC COEFFICIENTS AND WATER ACTIVITIES FOR VARIOUS ELECTROLYTES. Gazith, M. (comp.) (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Jan. 1965. 37p. Dep. mn.

Molal osmotic coefficients and water activities were calculated numerically and tabulated for 32 electrolytes, at 25°C. The present data are based on previously tabulated concentration and activity coefficient data. The method of calculation is described. (auth)

36332 (IFA-IS-31(1965)) THE STUDY OF ESR SIGNAL OF ACTIVE CHARS IN OXYGEN ATMOSPHERE. Ursu, I.; Grecu, V.; Barbur, I. (Institutul de Fizica Atomica, Academia R. P. R., Bucharest). [1965]. 11p. Dep.(mn).

A study was made of the dependence of ESR signal of active chars on the oxygen pressure and on its mixtures with diamagnetic gases. The line width variation of resonance signal expressed as function of oxygen pressure shows three distinctive regions: proportionality, logarithmic dependence, and, for larger pressures, inverse proportionality to the inverse of oxygen pressure. Diamagnetic gases such as N_2 and CH_4 do not change the oxygen effect. Assuming that the line width of resonance signal is proportional to the number of oxygen molecules adsorbed on the char, conclusions on the mechanism of molecular adsorbtion may be deduced. Between the adsorbed oxygen molecules there are repulsive forces, which determine both the equation of state of adsorbed phase and the adsorption isotherm. (auth)

36333 (LA-DC-6899) PREPARATION AND PROPERTIES OF SOME ALKALI FLUORIDE COMPLEXES OF PENTAVALENT PROTACTINIUM. Asprey, L. B.; Penneman, R. A.; Kruse, F. H. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1964]. Contract W-7405-eng-36. 9p. (CONF-650701-3). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Colloquium on Physical Chemistry of Protactinium, Paris.

Complex fluorides containing pentavalent protactinium and alkali fluoride were made, both from aqueous hydrofluoric acid solution and by fluorine oxidation of intimately ground mixtures containing PaF_4 and alkali fluoride. The major part of the work was done on the rubidium Pa(V) fluoride system. X-ray data are reported. Correlation of the properties of the complex fluorides of pentavalent protactinium with those of pentavalent uranium are made. (auth)

36334 (LA-DC-6900) FLUORIDE COMPLEXES OF TETRAVALENT PROTACTINIUM. Asprey, L. B.; Penneman, R. A. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1964]. Contract W-7405-eng-36. 9p. (CONF-650701-4). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Colloquium on Physical Chemistry of Protactinium, Paris.

The compound $(NH_4)_4PaF_8$ was made from NH_4F and PaF_4. It is isostructural with $(NH_4)_4UF_8$, $(NH_4)_4NpF_8$, $(NH_4)_4PuF_8$, and $(NH_4)_4AmF_8$. Details of the syntheses of this and other alkali fluoride complexes are given along with structural data. (auth)

36335 (LA-DC-7218) CRITICAL PHENOMENA IN FLUIDS. Hammel, E. F. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 41p. (CONF-650611-4) Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

From Symposium on Heat Flow Below 100 deg K and its Technological Applications, Grenoble, France.

The derivation of the properties of a fluid in the vicinity of the critical point for the topology of its PVT surface is discussed. It is shown that a singularity exists at the critical point on both the PVT and FTV surfaces, and hence predictions of thermodynamics near the critical point cannot be made using Taylor series expansions. The following properties are considered, comparing model studies and

experimental results: specific heat at constant volume, sound velocity, density, compressibility, degree of critical isotherm, second derivative of vapor pressure, and transport properties. It is concluded that the properties of fluids in the critical region are more anomalous than had been supposed. (D.L.C.)

36336 (N64-33904) TWO-CENTER COULOMB INTEGRALS. Geller, Murray (Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena). Oct. 1, 1964. Contract NAS 7-100. 23p. (JPL-TR-32-673; NASA-CR-59382). CFSTI, $1.00 cy.

One of the difficulties in the application of nonrelativistic quantum mechanics to molecular systems has been the evaluation of the integrals that arise from the use of trial wavefunctions. A derivation and expression for the general two-center Coulomb integral (over Slater-type atomic orbitals) is considered, based on the Fourier-convolution method. All of the Coulomb integrals through N = 4 are given in explicit form in terms of an auxiliary function W^{pq}_{mn} which is a simple one-dimensional integral. (auth)

36337 (NAA-SR-11235) THE CHEMICAL REACTIVITY OF URANIUM CARBIDE. Murbach, E. W. (Atomics International, Canoga Park, Calif.). June 30, 1965. Contract AT-11-1-GEN-8. 19p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

The chemical reactivity of uranium carbide is a function of its previous treatment. Freshly arc-melted uranium carbide is relatively unreactive toward oxygen, nitrogen, and CO_2. After exposure to laboratory air for a few days, the material becomes reactive. This exposure is accompanied by an increase in apparent surface area of the order of 100 cm^2 per gram. It is postulated that the increase in surface is caused by hydrolysis along grain boundaries and this increase in surface causes the enhanced reaction rates. (auth)

36338 (NP-15160) TRANSPORT STUDIES OF DEFECT STRUCTURE INORGANIC COMPOUNDS. Final Technical Report, September 30, 1964-March 31, 1965. (Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.). Contract Nonr-3800(00). 30p.

Research on oxygen-ion conducting electrolytes and chemisorption studies are summarized. Among the studies were: vacancies in substituted zirconia, Seebeck coefficient of $(ThO_2)_{1-x}(YO_{1.5})_x$, electric properties of Sc_2O_3-MgO solid solutions, conductivity of high-purity stabilized ZrO_2, interaction of oxygen with Pt, oxygen reduction by silver-based alloy electrodes in KOH solution, Ag-MgO surfaces, reactions of O_2 and H_2O_2 at Ag electrodes in alkaline solutions, ortho-para conversion of H on Ag, and exchange of oxygen at Ag surfaces. (D.L.C.)

36339 (NYO-3000-7) THE ABSORPTION OF HYDROGEN AND DEUTERIUM BY PALLADIUM-RICH ALLOYS. Progress Report, June 1, 1964-June 1, 1965. Flanagan, Ted B. (Vermont Univ. and State Agriculture Coll., Burlington). Contract AT(30-1)-3000. 24p. Dep.(mn); $1.00 (cy) 1(mn) CFSTI.

The statistical mechanical proton absorption model was extended to incorporate the variation of electron donation energy with the density of empty states in Pd. Absorption isotherms and diffusion constants were measured for hydrogen in the alpha phase of Pd. The absorption of hydrogen and deuterium by a series of Au-Pd alloys was measured. Relations between electrical resistivity and hydrogen content were determined for α-Pd and Au-Pd. (D.L.C.)

36340 (ORNL-P-814) AN ALL-METAL CELL TECHNIQUE FOR THE MEASUREMENT OF THE Emf OF MOLTEN METAL-METAL HALIDE SOLUTIONS CORROSIVE TO CERAMICS. Bronstein, Harry R. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 3p. (CONF-650502-3) Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Electrochemical Society, San Francisco.

The need for an all-metal cell technique for corrosive rare earth-rare earth halide solutions is pointed out. Such a technique, using Ta metal tubes with sintered porous Ta plugs welded in the sides, was applied to the Hg(s), $HgSO_4$ (saturated solution)/Ag(s), Ag_2SO_4 (saturated solution) cell. The potential was determined to be +41.5 ± 0.1 mv at 25°, in good agreement with previous values. The technique was also applied to the molten Cd-$CdCl_2$ system at 635°C. For 2 and 10 mole % Cd-$CdCl_2$ electrodes vs the saturated Cd-$CdCl_2$ electrode, the potentials were +111.0 and +33.0 mv, respectively, in good agreement with values (+113 and +35 mv) obtained in an all-glass apparatus. (D.L.C.)

36341 (ORNL-P-862) ROTATING DISK STUDY OF THE DISSOLUTION OF ZIRCONIUM IN HF-H_2SO_4. Meyer, R. E.; Zetti, Sandra (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 3p. (CONF-650502-1) Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Electrochemical Society, San Francisco.

The dissolution of crystal bar zirconium in mixtures of hydrofluoric acid and sulfuric acid was investigated by use of a rotating disk electrode system. The presence of the sulfuric acid in relatively large amounts considerably reduces the rates as compared to solutions of hydrofluoric acid and nitric acid. In addition, the reaction, which is normally first order, changes to second order in the presence of large amounts of sulfuric acid. A kinetic equation which accounts for these results can be derived if it is assumed that both the hydrofluoric acid and the sulfate ion are adsorbed. (auth)

36342 (ORNL-P-899) MOLTEN FLUORIDES AS NUCLEAR REACTOR FUELS. Blankenship, F. F.; McDuffie, H. F.; Thoma, R. E.; Grimes, W. R. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-36. 5p. (CONF-650502-2) Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Electrochemical Society, San Francisco.

Molten mixtures of ^7LiF, BeF_2, ZrF_4, and UF_4 show nuclear properties, chemical stability, and phase behavior required of circulating fuels for high temperature nuclear reactors. The liquids are adequate heat transfer media and are compatible with moderator graphite and with INOR-8. The fluoride-graphite-metal system withstands radiation, fission of uranium, and accumulations of fission products without appreciable damage. (auth)

36343 (TID-21847) THE THERMODYNAMICS AND KINETICS OF COORDINATION COMPOUNDS. Progress Report. Cefola, Michael; Gentile, Philip S. (Fordham Univ., New York. Dept. of Chemistry). Feb. 4, 1965. Contract AT(30-1)-906. 68p. Dep.(mn); $3.00(cy), 2(mn) CFSTI

Work on the following subjects is described: nuclear magnetic resonance in tautomeric equilibria of 2,4-pentadione, chemistry of praseodymium β-diketone chelates Szilard-Chalmers reaction, pyridine halide complexes, kinetics of formation of acetylacetone complexes of Cu and Ni, uranyl nitrate-urea complexes, complexes between diacetamide and alkali and alkaline earth metal salts, and thermodynamic studies of chelates in mixed solvents. (D.L.C.)

36344 (UCRL-11816) PHYSICAL CHEMISTRY OF GLASS-METAL INTERFACES. Pask, Joseph A.; Borom, Marcus P. (Lawrence Radiation Lab., Univ. of California, Berkeley). Feb. 5, 1965. Contract W-7405-eng-48. 37p. Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

The phase equilibria of glass-metal heterogeneous systems are discussed. Thermodynamic equilibrium is established when the molten silicate becomes saturated with the low valence oxide of the metal. If the two phases are not at equilibrium, reactions of a redox type occur in an effort to achieve this condition. When the glass contains transition metal oxides whose metals have a lower oxidation potential than the base metal and form alloys with the base metal, reactions occur that result in adjustments of the compositions of the alloy and glass at the interface in a drive to achieve equilibrium. Presence of multivalent cations also assists in this drive by providing a transport mechanism for atmospheric oxidation of the base metal. Maintenance of equilibrium at the interface while the whole system

moves toward thermodynamic equilibrium is dependent upon the kinetics of the various reactions. When equilibrium is present at the interface, an equal attractive force is exerted on the intermediate oxygen layer by the metal and glass. This condition leads to a balance of bond energies and a continuation of the electronic structure across the interface which is equivalent to a chemical bond. This condition, further, corresponds to a situation where the surface energy of the metal is lowered by an amount equivalent to the surface energy of the molten glass; this situation corresponds to a zero contact angle in a sessile drop experiment. (auth)

36345 (UCRL-11927) MOLECULAR-BEAM STUDIES OF LANTHANUM MONOXIDE (thesis). Walsh, Robert Michael (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 1965. Contract W-7405-eng-48. 42p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A new method was devised to establish the ground state of a high-temperature molecule by examination of the fluorescent spectrum of a molecular beam. An apparatus to form a molecular beam was constructed and a beam of lanthanum monoxide generated. The new method was successfully applied to establish the ground state as that designated as $X^4\Sigma$ in earlier spectral studies. The suitability of the LaO beam for use in the determination of the radiative lifetime by means of the phase-delay technique is discussed, together with a consideration of the light sources that might be used for such a measurement. The lifetime of the $B^2\Sigma$ state of LaO was estimated to be on the order of 10^{-7} sec. The known electronic spectra of LaO, ScO, and YO are discussed and an extension of the molecular-beam fluorescence technique is proposed to settle a problem of the location of an excited state. (auth)

36346 (UCRL-16093) PHOTOIONIZATION OF ALKALI-METAL VAPORS (thesis). Lee, Yuan-tseh (Lawrence Radiation Lab., Univ. of California, Berkeley). June 1965. Contract W-7405-eng-48. 78p. Dep.(mn); $3.00 (cy), 2(mn) CFSTI.

The vapors of potassium, rubidium, and cesium were photoionized with light absorbed in the discrete region of the atomic spectrum. The energy threshold for the ionization process was determined and the ions produced identified by mobility measurements. The data give lower limits for the dissociation energies of K_2^+, Rb_2^+, and Cs_2^+. Each of these molecular ions has a bond energy approximately 50% greater than that of the corresponding neutral molecule. In addition, lower limits for the electron affinities of the alkali atoms and values for the mobilities of Rb^+, Rb_2^+, Cs^+, and Cs_2^+ in their present vapor are given. (auth)

36347 (AEC-tr-6597) A NEW METHOD OF MEASURING THE RELATIVE ABUNDANCE OF ISOTOPES. ISOTOPE DISTRIBUTION AND THE ATOMIC WEIGHT OF HAFNIUM. Mattauch, J.; Ewald, H. Translated from Naturwissenschaften, 31: 487-90(1943). 5p. Dep. mn, $1.10(fs), $0.80(mf) JCL.

An improved photometric method using a reference element to combine the advantages of the electrometric and photometric methods, was used on hafnium. The results, which were compared with these of Aston and Dempster, were: mean mass number of Hf = 178.543 ± 0.004; isotopic abundances: ^{174}Hf, 0.18%; ^{176}Hf, 5.30%; ^{177}Hf, 18.47%; ^{178}Hf, 27.13%; ^{179}Hf, 13.85%; and ^{180}Hf, 35.14%. The atomic weight is 178.50 ± 0.02. (D.L.C.)

36348 COMPOUNDS OF LANTHANUM AND CERIUM WITH PAR. Spacu, P. (and others). Acad. Rep. Populare Romine, Studii Cercetari Chim., 12: 113-18(1964).

Compounds formed between PAR and cerium and PAR and lanthanum were investigated. Equimolar solutions of 10^{-4} and 2×10^{-4} M containing reagent and salts of rare earths were used, along with a spectrophotometer. In concentrated solutions, the compounds of cerium and lanthanum with PAR precipitate in the form of red crystals, whose color is darker in cerium and lighter in lanthanum. Both in solution and in crystallized state the rare earths combine with 4-(2-pyridylazo)-resorcinol (PAR) yielding compounds of the type $[MeR_2]^-$. (Rumanian Sci. Abstr., Nat. Sci., Vol. I, No. 6, 1964)

36349 ISOTOPIC H-D EFFECTS IN THE BEHAVIOR OF PALLADIUM POWDER ELECTRODES. Znamirovschi, V. Acad. Rep. Populare Romine, Studii Cercetari Fiz., 15: 246-58(1964).

The use of powder electrodes for determining the isotopic H-D effect on palladium powder is discussed, and it is pointed out that the potential of a palladium powder electrode may be considered as a characteristic parameter of the disperse solid phase involved; the method makes it possible to check and to study the surface changes in the solid phase as well as the process of hydrogen adsorption. It is also shown that the isotopic effect of deuterium has been evinced by measuring the potential of the palladium powder electrode in the hypothesis of a mechanism of isotopic exchange between the chemisorbed phase and the liquid phase, and that this isotopic effect could be used as a method of analysis for determining the concentration of deuterium in water. (Rumanian Sci. Abstr., Nat. Sci., Vol. I, No. 7, 1964)

36350 AMMONIATES OF URANIUM TRICHLORIDE AND TETRACHLORIDE. Berthold, H. J.; Knecht, H. (Universitaet, Mainz, Ger.). Angew. Chem. Intern. Ed. Engl., 4: 431-2(May 1965).

Uranium trichloride and UCl_4 react with gaseous ammonia at room temperature and with liquid ammonia at < −34°C to form ammoniates with the compositions $UCl_3 \cdot (6.8-6.9)NH_3$ and $UCl_4 \cdot (7.3-7.5)NH_3$ at 22−23°C and 760−790 mm. If the reaction is conducted in liquid ammonia under pressure at room temperature and the excess ammonia is subsequently allowed to evaporate, UCl_3 gives the same ammoniate, but UCl_4 then binds 9 to 10 moles of NH_3. In liquid ammonia, in addition to ammoniate formation, a small amount of ammonolysis also occurs, detectable from the reduction in Cl content to 2.8 with UCl_3 and to 3.5 with UCl_4. Isothermal decomposition of the ammoniates in a stream of N_2 nitrogen (70 ml/min) at ca 20°C leads to $UCl_3 \cdot 3NH_3$ and $UCl_4 \cdot 4NH_3$, which are both stable up to ~45°C. Decomposition at higher temperatures leads without detectable intermediates to $UCl_3 \cdot NH_3$ and $UCl_4 \cdot NH_3$. These two ammoniates are stable up to about 300°C. They decompose above 350°C with partial ammonolysis. With the exception of $UCl_4 \cdot NH_3$, all the ammoniates are crystalline and have characteristic x-ray diagrams. Ammoniates claimed to be stable above room temperature, namely $UCl_4 \cdot 12NH_3$, $UCl_4 \cdot 8NH_3$, $UCl_4 \cdot 5NH_3$, $UCl_4 \cdot 3NH_3$, and $UCl_4 \cdot 2NH_3$, could not be detected. The higher ammoniates of U(III) and U(IV) chlorides absorb gaseous CO_2 with great rapidity; the CO_2 reacts with part of the bonded ammonia to form ammonium carbamate, which does not occur as a separate phase but is built into the lattices of the higher ammoniates without significant alterations of their spacious structures. Comparison of these ammoniate-carbamates with the ammoniates obtained on pyrolysis revealed that only that portion of the ammonia reacts with CO_2 which is readily released at room temperature, and which is apparently only loosely bound inside the large hollows of the ammoniate lattices. (BBB)

36351 HIGH-TEMPERATURE AMMONOLYSIS OF URANIUM TRICHLORIDE AND TETRACHLORIDE. Berthold, H. J.; Knecht, H. (Universitaet, Mainz, Ger.). Angew. Chem. Intern. Ed. Engl., 4: 433-4(May 1965).

Uranium trichloride and UCl_4 undergo ammonolysis above 350°C. Between 450 and 500°C, UCl_3 gives rise to NH_4Cl and a mixture of amorphous amido compounds (UNH_2Cl_2 plus $U(NH_2)_2Cl$). At higher temperatures the latter are transformed via crystalline uranium imidochloride, U(NH)Cl, into uranium nitride with the composition $UN_{1.73-1.75}$. The uranium mononitride, UN, expected as a final product of the ammonolysis, is not formed. One g of UCl_3 is completely ammonolized after 15 min. at 800°C. UCl_4 reacts with ammonia at about 450°C to form amorphous U(IV) amidotrichloride, UNH_2Cl_3. At about 475°C, this compound is reduced to crystalline UCl_3, which was detected analytically and by its x-ray diffraction pattern.

The ammonolysis then continues as for UCl_3. U(NH)Cl obtained by various routes between 500 and 550°C crystallizes in a PbFCl layer lattice (space group D_{4h}^1 -P4/nmm) with two molecules in the tetragonal unit cell. The lattice constants are a = 3.972 ± 0.005 A and c = 6.810 ± 0.010 A. Intensity calculations gave the parameter u = 0.168 ± 0.002 for U and the parameter v = 0.63 ± 0.01 for Cl. The distance between the NH^{2-} anions (2.809Å) is remarkably short and suggests the occurrence of H bridges between the NH^{2-} ion layers. Other nearest neighbors are U^{3+}-$4NH^{2-}$ = 2.292 Å, U^{3+}-$4Cl^-$ = 3.127 Å, U^{3+}-Cl^- = 3.146 Å. The Cl-Cl distance between neighboring layers is 3.32 Å. (BBB)

36352 THERMOGRAPHIC STUDIES OF TERNARY AND BINARY SYSTEMS OF UO_2, UCl_4, AND KCl. Martynova, N. S.; Vasil'kova, I. V.; Susarev, M. P. At. Energ. (USSR), 18: 616-23(June 1965).

Thermographic studies were made of UCl_4–KCl, UO_2–KCl, UO_2–UCl, and UO_2–UCl_4–KCl systems. The pressure of K_2UCl_6 and $UOCl_2$ in the binary systems of UCl_4–KCl and UO_2–UCl_4 permits the separation of the ternary system UO_2–UCl_4–KCl into subsystems: $UOCl_2$–K_2UCl_6–UCl_4, UO_2–$UOCl_2$–K_2UCl_6 and UO_2–UCl_6–KCl. The first of the developed systems has the lowest melting point and is considered as an independent ternary system. (R.V.J.)

36353 PRECIPITATION OF URANYL AND AMMONIUM ARSENATES AND SOME OF THEIR PROPERTIES. Korenev, M. A.; Nevskii, B. V.; Zorina, Z. P.; Ambartsumyan, Ts. L.; Nazarenko, N. G. At. Energ. (USSR), 18: 647-8(June 1965).

X ray and thermographic analysis of uranyl nitrates (with 0.5 g/l uranium) showed that as 20°C and arsenic–uranium ratio near stoichiometric the precipitation of uranyl and ammonium arsenates from uranyl nitrates began at pH ≈ 1.5. At pH = 2.5 the main part of uranium precipitation was accomplished by the ammonium neutralization. Prepared uranyl and ammonium arsenates looked like a fine crystal line, lemon-yellow powder with bright green luminescence in ultraviolet light, with the chemical formula $UO_2NH_4AsO_4 \cdot 3H_2O$. Formation of uranyl and ammonium arsenates and di- and trivalent iron and aluminum arsenates as functions of uranium (0.250g/l) concentration and pH of the solution was determined. The pH values for the initial and final uranyl and ammonium arsenates precipitation were determined. The constructed curves show that uranyl and ammonium arsenates and trivalent iron co-precipitated at close pH values which prevents selective uranium separation. Precipitation of divalent iron and aluminum begins at larger pH than uranium therefore selective precipitation of uranium is easily achieved in the presence of divalent iron and aluminum ions. (R.V.J.)

36354 ON COMPOUNDS OF FORMULA MX FORMED FROM RARE EARTHS WITH P, As, Sb, Bi, S, Se, AND Te. COMPOUNDS OF THULIUM AND LUTETIUM. Iandelli, Aldo. Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat., (8), 37: 160-4(Sept.-Oct. 1964). (In Italian)

Compounds of Tm and Lu with P, As, Sb, Bi, S, Se, and Te were made by direct reaction between the elements. They were examined structurely and magnetically. All the compounds had structures of the NaCl type. The lattice constants were tabulated. The results and conclusions from a study of the MX compounds of all the rare earths with metalloids are summarized. (J.S.R.)

36355 LOW-TEMPERATURE HEAT CAPACITY OF CERIUM TRIHYDRIDE. CRYSTAL FIELD EFFECTS IN RARE EARTH METAL HYDRIDES. [PART] II. Bieganski, Z.; Fesenko, W.; Stalinski, B. (Inst. of Structural Research, Wroclaw, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 13: 227-30(1965).

Crystal field effects on the low-temperature thermodynamic properties of $CeH_{2.88}$ were studied. The heat capacity was measured in the temperature range from 21 to 361°K. The Cp-T plot showed a pronounced anomaly at ~255°K. Magnetic susceptibility measurements in this temperature range did not reveal any anomalous behavior in this temperature range. The fcc structure of the compound was maintained on both sides of the anomaly. (M.C.G.)

36356 CRYSTALLOGRAPHIC STUDY OF NEW SELENIDES OF THE RARE EARTHS AND SODIUM. Ballestracci, R.; Bertaut, E.-F. (CEA-CEN, Grenoble, France). Bull. Soc. Franc. Mineral. Crist., 88: 136-8 (Jan.-Mar. 1965). (In French)

A series of selenides of the rare earths and of Na with the formula $TNaSe_2$ is described. As with the sulfides, a primary form A, of the NaCl type, which exists for La and Eu was detected and a rhombic form B whose space group is $R\bar{3}m$ and which can be obtained for all the rare earths from La to Er was also detected. The particular role of Eu and the continuity of the A and B forms were shown. (tr-auth)

36357 SIMPLE METHOD FOR THE PRODUCTION OF SCANDIUM OXIDE FROM THORTVEITITE MATERIAL. Richter, Herfried; Zobel, Dietmar (Forschungsabteilung des VEB Stickstoffwerk Piesteritz, Wittenberg, Ger.). Chem. Tech. Leipzig), 17: 234-5(Apr. 1965). (In German)

The production of scandium oxide from a low-grade thortveitite material is described. The material was decomposed by fusion with caustic soda. The separation of scandium from the associated elements was achieved by extraction from hydrochloric acid, rhodanide-containing solutions with ether and by precipitation as the basic scandium tartrate. (tr-auth)

36358 SOLID ELECTROLYTE CAPACITORS UTILIZING ANODES DERIVED FROM TANTALUM–TITANIUM ALLOYS. Kolski, Thaddeus L.; Ling, Harry W. (E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.). Electrochem. Technol., 3: 67-70(Mar.-Apr. 1965).

Solid electrolyte capacitors rated at various voltages were prepared using anodes of porous tantalum derived from tantalum–titanium alloys by the process of titanium volatilization in vacuum at high temperatures. Excellent initial characteristics and life in excess of 2000 hr at 85°C and full rated voltage in low-impedance circuits demonstrated the feasibility of such devices at 35, 50, 75, and 100 v. Electrical characteristics of the devices were not seriously degraded as a result of life testing. Temperature dependence of capacitance, dissipation factor, and d-c leakage in the range from −55 to +85°C is reported. (auth)

36359 ELECTROLYTIC CAPACITORS UTILIZING ANODES DERIVED FROM TANTALUM–TITANIUM ALLOY. Ling, Harry W.; Kolski, Thaddeus L. (E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.). Electrochem. Technol., 3: 71-4(Mar.-Apr. 1965).

Polar liquid electrolyte capacitors with ratings up to 300 v were fabricated using surface-enhanced anodes derived from tantalum–titanium alloy. Few parametric failures were observed in over 200,000 device hours during a 2800-hr life test at 85°C. A comparison of properties before and after life testing showed good capacitance stability. Capacitance, leakage current, and dissipation factor were measured as a function of temperature. (auth)

36360 A NEW HIGH-CURRENT CATHODE FOR OPERATION IN REACTIVE GASES. Weatherly, M. H.; Anderson, J. E. (Union Carbide Corp., Indianapolis). Electrochem. Technol., 3: 80-4(Mar.-Apr. 1965).

A cathode, designated as the "insert cathode," was developed for electric arc operation at high currents. It consists of a material that is a good electron emitter embedded in a water-cooled metal holder that has a high coefficient of thermal conductivity. Using this technique, a considerable number of emitting materials that are chemically stable in different reactive atmospheres are available as cathodes. The experimental operation and principles of the insert cathode are described using a zirconium insert in a copper holder as a prime example. Zirconium inserts were operated in a stable manner at several hundred amperes in oxygen, air, nitrogen, and a nitrogen-hydrogen mixture. (auth)

36361 RAPID PLUTONIUM ELECTRODEPOSITION. Tomlin, D.; Barnett, G. A. (Atomic Energy Establishment, Winfrith, Dorchester, Eng.). Health Phys., 11: 783(Aug. 1965).

Observations in the field of Pu and Np electrodeposition on to standard polished stainless steel counting disks from a chloride system are reported. Using tracer levels of ^{239}Pu α-activity (~ 5000 cpm) in 5 ml of an electrolyte, (M in NA4Cl and 0.01 M in oxalic acid) deposits were obtained on stainless steel that approached 100 percent in 15 min. Neptunium-239 is diminished under similar conditions to <1 percent after a 15-min deposition. (H.G.D.)

36362 STUDIES ON URANYL AND THORIUM COMPLEXES WITH 3-METHYLGALANGIN. Katyal, Mohan; Singh, R. P. (Univ. of Delhi). Indian J. Chem., 3: 281-2 (1965).

3-Methylgalangin was found to give two orange colored complexes with uranyl ion and one yellow colored complex with thorium ion. Spectrophotometric studies of the two uranyl-3-methylgalangin complexes and the yellow colored thorium-3-methylgalangin complex show that the metal-ligand ratio in the complexes are 1:1 and 1:2, and 1:1, respectively. The thorium complex obeys Beer's law in the concentration range 1.8 to 13 ppm. The average stability constant of the thorium complex is 3.5×10^4 at 20° and pH 2.6. (auth)

36363 GONIOMETRIC STUDY OF TERBIUM SULPHATE OCTAHYDRATE. Kashyap, Rupendra Kumar (Agra Coll., India). Indian J. Phys., 39: 97-8(Feb. 1965).

The crystal structure of $Tb_2(SO_4)_3 \cdot 8H_2O$ was studied. This crystal was formed from an aqueous solution of rare earth salts in triple-distilled water; and the interfacial angles were measured with a two circle goniometer. The forms of the crystal were found to be orthopinacoids and basalpinacoids. The normal crystallographic angles and reflections are listed. (J.F.P.)

36364 A NEW ELECTRONIC TRANSITION IN THE BeF MOLECULE. Madhusudana Rao, K.; Tiruvenganno Rao, P. (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 3: 177-8(May 1965).

A doublet system of bands was observed in the visible region of the emission spectrum of the BeF molecule excited by a high-frequency discharge. From the magnitude of the vibrational constants of the lower state it was concluded that the lower state of the system is the same as the first excited state A of the BeF molecule. The constants of the upper state were estimated as $\omega_e' = 1420.1$ cm^{-1} and $x_e'\omega_e' 11.6$ cm^{-1}. (auth)

36365 RARE EARTH SESQUISELENIDES AND SESQUITELLURIDES WITH THE Sc_2S_3 STRUCTURE. Dismukes, J. P.; White, J. G. (Radio Corp. of America, Princeton, N. J.). Inorg. Chem., 4: 970-3(July 1965).

The sesquiselenides of Sc, Yb, Tm, Ho, and Y and the sesquitellurides of Tm, Ho, Dy, and Y have the Sc_2S_3 structure which is a superstructure of the NaCl type based on the ordering of cation voids. The tellurides with this structure were stable only over a very narrow range of cation/anion radius ratio, centered at about 0.414. This suggested that the tellurides require both cation-anion and anion-anion contacts to stabilize the structure. The selenides were stable over a wider range of radius ratio, and the relative values of the orthorhombic cell parameters a, b, and c showed appreciable deviation from the ideal values 2, $\sqrt{2}$, and $3\sqrt{2}$, respectively, times the NaCl subcell parameter a_0. Thus, factors other than geometrical considerations were important in determining the stability of the selenides. (auth)

36366 CRYSTAL STRUCTURES OF THE TRIFLUORIDES, TRICHLORIDES, TRIBROMIDES, AND TRIIODIDES OF AMERICIUM AND CURIUM. Asprey, L. B.; Keenan, T. K.; Kruse, F. H. (Los Alamos Scientific Lab., N. Mex.). Inorg. Chem., 4: 985-6(July 1965). (LA-DC-6975)

The previously unreported lattice constants and crystal symmetries of the trifluoride, trichloride, tribromide, and triiodide of curium are given. Similar data for the isostructural trihalides of americium (except for the trifluoride) were redetermined to a higher degree of precision. Correlations were made between these actinide trihalides and the corresponding lanthanide trihalides. Curium trifluoride was hexagonal, LaF_3-type, space group $P6_3/mmc$-D_{6h}^4. Americium and curium trichlorides were hexagonal, UCl_3-type, space group $P6_3/m$-C_{6h}^2. The tribromides were orthorhombic, $PuBr_3$-type, space group $Cmcm$-D_{2h}^{17}. The triiodides were hexagonal, BiI_3-type, space group $R3$-C_{3i}^2. When treated with hydrogen at elevated temperatures, no reduction of these trivalent americium or curium trihalides was observed. (auth)

36367 THE CRYSTAL STRUCTURE OF DITECHNETIUM DECACARBONYL. Bailey, Marcia F.; Dahl, Lawrence F. (Univ. of Wisconsin, Madison). Inorg. Chem., 4: 1140-5(Aug. 1965).

A three-dimensional single-crystal x-ray analysis of $Tc_2(CO)_{10}$ made possible a detailed comparison of the molecular features of $Tc_2(CO)_{10}$ and $Mn_2(CO)_{10}$. These two compounds and $Re_2(CO)_{10}$ are isomorphous and consist of dimeric molecules of approximately D_{4d} symmetry in which each metal atom is octahedrally coordinated to five carbonyl groups and the other metal atom such that the equatorial carbons are arranged in a staggered configuration. Crystals of $Tc_2(CO)_{10}$ contain four dimeric molecules in a monoclinic unit cell of symmetry 12/a and of dimensions $a = 14.65 \pm 0.03$, $b = 7.18 \pm 0.02$, and $c = 14.93 \pm 0.03$ Å, and $\beta = 105.6 \pm 0.1°$. Anisotropic refinement of all atoms resulted in final discrepancy factors of $R_1 = 6.9\%$ and $R_2 = 7.4\%$ for 1296 observed reflections. The observed Tc–Tc bond distance was 3.036 ± 0.006 Å compared to a Mn–Mn distance of 2.923 ± 0.003 Å in $Mn_2(CO)_{10}$ and a Re–Re distance of 3.02 ± 0.01 Å in $Re_2(CO)_{10}$. All of the carbonyl groups were less strongly bonded to the metal in $Tc_2(CO)_{10}$ than in $Mn_2(CO)_{10}$, as evidenced by longer Tc–C bond distances (Tc–C 1.98 Å. (av) vs Mn–C 1.83 Å (av)). The average Tc–C bond distance of the four equatorial carbonyls was significantly greater (by 0.10 Å.) than the Tc–C_1 bond distance of the apical carbonyl; however, the average equatorial C–O bond distance of 1.12 Å was significantly less than the apical C_1–O_1 distance of 1.21 Å, so that all nonbonding Tc . . . O distances were equal within the estimated error. The four equatorial carbonyl groups attached to each technetium were bent away from the apical carbonyl toward the other half of the dimer. (auth)

36368 A URANIUM(V)–URANIUM(VI) COMPLEX AND ITS EFFECT ON THE URANIUM(V) DISPROPORTIONATION RATE. Newton, T. W.; Baker, F. B. (Los Alamos Scientific Lab., New Mex.). Inorg. Chem., 4: 1166-70(Aug. 1965) 1965). (LA-DC-7001)

Spectrophotometric and kinetic evidence is given for the formation of a complex, $U_2O_4^{+}$. The heat and entropy of formation from UO_2^{+} and UO_4^{+4} were found to be -1.9 ± 0.3 kcal $mole^{-1}$ and -1 ± 1 cal $mole^{-1}$ deg^{-1} in perchlorate solutions 2.0M in ionic strength. The complex had a characteristic absorption band at 7370 A (ϵ 27M^{-1} cm^{-1}). The disproportionation rate of the complex was much lower than that of UO_2^{+}, so U(V) solutions were greatly stabilized in the presence of U(VI). Rates of U(V) disproportionation were extrapolated to zero U(VI) to provide rate constants, which were more reliable than previously available. Heats and entropies for the net activation process $2UO_2^{+} + H^{+} = [UO_2 \cdot UO_2 \cdot H^{3+}]^*$ were found to be 11.0 ± 0.4 kcal $mole^{-1}$ and -11.0 ± 1.5 cal $mole^{-1}$ deg^{-1}. (auth)

36369 ISOTOPIC FRACTIONATION IN ELECTRON-TRANSFER REACTIONS. THE ROLE OF NONBRIDGING LIGANDS. Green, M.; Schug, K.; Taube, H. (Univ. of Chicago). Inorg. Chem., 4: 1184-6(Aug. 1965).

The kinetic fractionation factors, d ln $[N^{14}]$/d ln $[N^{15}]$, for the nitrogen atoms in the ammine ligands of $Co(NH_3)_5OH_2^{3+}$, $Co(NH_3)_5Cl^{2+}$, $Co(en)_2NH_3Cl^{2+}$, and $Co(en)_2NH_3OH_2^{3+}$ during reactions with $Cr^{+2}(aq)$ were measured. It was significant that they were very small (1.002 and 1.001) for the first two ions and that they were identical for NH_3 cis or trans to the

bridging group. Thus, in these particular reactions, there seemed to be little rearrangement in the $Co-NH_3$ residue attendant on electron transfer. (auth)

36370 SYNTHESIS OF A NEW DEUTERIUM-LABELED TETRABORANE, μ-DEUTERIOTETRABORANE-10. Norman, Arlan D.; Schaeffer, Riley (Indiana Univ., Bloomington). Inorg. Chem., 4: 1225-7(Aug. 1965).

A monodeuterium-labeled tetraborane was prepared by reacting 2.52 m moles of pentaborane-11 with 4.0 ml of deuterium oxide for 2 min at 0°C in a sealed tube. The reaction was quenched to −196°C and noncondensable gases were removed. The product was crudely separated from deuterium oxide by passage through a −80°C trap and finally purified by low-temperature fractional distillation. Pure μ-deuteriotetraborane-10 was collected from the column at −117 to −120°C. Yields were estimated on the basis of the amount of HD recovered from the reaction and ranged from 95 to 97%. (F.J.H.)

36371 PLUTONIUM BORIDES. Eick, Harry A. (Los Alamos Scientific Lab., N. Mex.). Inorg. Chem., 4: 1237-9 (Aug. 1965). (LA-DC-6904)

Preparations of plutonium borides by heating plutonium with boron in a furnace and by arc melting plutonium and boron are reported. The products of both preparations were examined by x ray-powder diffraction. The arc-cast specimens were examined micrographically. (F.J.H.)

36372 PREPARATION AND PHYSICO-CHEMICAL PROPERTIES OF LANTHANUM SULFIDES. Marchenko, V. I.; Samsonov, G. V. (Inst. of Problems in Metallography, Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Neorgan. Materialy, 1: No. 1, 47-52(Jan. 1965). (In Russian)

Studies were made of the preparation and physical properties of lanthanum sesqui- and monosulfides. The specific electrical resistance at 20 to 1000°C, thermal emf, magnetic susceptibility, and the width of the lanthanum sesquisulfide forbidden zone were determined. The thermal coefficients of the monosulfides electrical resistance were found. (R.V.J.)

36373 CONSTITUTION DIAGRAMS OF CALCIUM ORTHOSILICATE−NEODYMIUM ORTHOSILICATE AND CALCIUM ORTHOSILICATE−LANTHANUM ORTHOSILICATE. Toropov, N. A.; Fedorov, N. F. (Leningrad Technological Inst.). Izv. Akad. Nauk SSSR, Neorgan. Materialy, 1: No. 1, 126-30(Jan. 1965). (In Russian)

Crystal-optical and x-ray analyses were used to determine the constitution diagrams for $Ca_2SiO_4-Nd_4(SiO_4)_3$ and $Ca_2SiO_4-La_4(SiO_4)_3$ systems at 1650°C to the melting point. Results indicated simple eutectoid type systems with the eutectics between the solid solutions with $\alpha-Ca_2SiO_4$ base and the rare earth ortho silicate. (R.V.J.)

36374 ISOTOPIC EXCHANGE OF HYDROGEN ATOMS IN CYCLOPENTADIENYLRHENIUMTRICARBONYL. Nesmeyanov, A. H.; Kursanov, D. N.; Setkina, V. N.; Kislyakova, N. V.; Kolobova, N. E.; Anisimov, K. N. (Inst. of Elementary Organic Compounds, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 4, 762(1965). (In Russian)

Kinetics of isotopic exchange of hydrogen atoms between cyclopentadienylrheniumtricarbonyl and solutions of trifluoroacetic and sulfuric acids ($H_0 = 7.21$) showed that the rate of the exchange is equal to 0.7×10^{-6} sec^{-1} at 25°C. Correlations of the rate of isotopic exchange in cyclopentadienyl rings bonded with rhenium and manganese showed that the hydrogen exchange in cyclopentadienyl with the manganese bond (3.9×10^{-6} sec^{-1}) is five times higher than with rhenium. (R.V.J.)

36375 ON A STRUCTURAL TYPE IN THE RANGE OF SOME RARE EARTH OXYORTHOSILICATES. Smolin, Yu. I.; Shepelev, Yu. F.; Bondar, I. A.; Toropov, N. A. (Inst. of Chemical Silicates, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 5, 925-6(1965). (In Russian).

X-ray structural analyses were made of mono- and polycrystals of dysprosium, holmium, erbium, and ytterbium oxyorthosilicates ($Ln_2O_3 \cdot SiO_2$) belonging to the third group of rare earth orthosilicates. Tabulated parameters of unit cells in Å showed that Dy, Ho, Er, and Yb oxyorthosilicates are isostructural (the space group $P2_12_12$, $Z = 12$). (R.V.J.)

36376 OXALATE COMPLEXES OF NIOBIUM AND TANTALUM COMPOUNDS. Nevzorov, A. N.; Songina, O. A. (S. M. Kirov Kazakh State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Khim. i Khim. Tekhnol., 6: 163-4(1963). (In Russian)

The solubility and decomposition temperature of $K_3[NbO(C_2O_4)_3] \cdot 2H_2O$ compounds were determined and a tantalum oxalate compound with the molar ratio $Ta : C_2O_4 : K = 1 : 1 : 1$ was separated. (R.V.J.)

36377 THERMODYNAMIC FUNCTIONS OF HAFNIUM HALIDES. Aleksandrovskaya, A. M.; Godnev, I. N.; Sverdlin, A. S. (Ivanov Chemico-Technological Inst., USSR). Izv. Vysshikh Uchebn. Zavedenii, Khim. i Khim. Tekhnol., 6: 165-6(1963). (In Russian)

Thermodynamic functions of HfI_4, $HfCl_4$, and $HfBr_4$ were calculated using the normal oscillation frequencies (in cm^{-1}) and interatomic distances Hf−Cl, Hf−Br, and Hf−I (in Å). The calculated $HfCl_4$ entropy at 485 and 496°K was in good agreement with calorimetric measurements. (R.V.J.)

36378 THERMAL STUDIES OF $TaCl_5-KCl-AlCl_3$ AND $NbCl_5-KCl-AlCl_3$ SYSTEMS. Chikanov, N. D.; Palkin, A. P.; Bizyaeva, M. K. (Voronezh State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Khim. i Khim. Tekhnol., 6: 355-60(1963). (In Russian)

Differential thermographic analyses were made and melting diagrams were constructed for $TaCl_5-KCl-AlCl_3$, and $NbCl_5-KCl-AlCl_3$ systems. The surface liquidus of the systems consisted of primary crystallization fields KCl, $KTaCl_6(KNbCl_6)$, $KAlCl_4$, $AlCl_3$, and $TaCl_5(NbCl_5)$. In the $TaCl_5-KCl-AlCl_3$ and $NbCl_5-KCl-AlCl_3$ systems the cross sections of $KAlCl_4-TaCl_5(NbCl_5)$ and $KAlCl_4-KTaCl_6$ $(KNbCl_6)$ were stable diagonals. Crystallization of pentachloride-rich complexes exhibited straitation along the main portion of the surface formed by $TaCl_5(NbCl_5)-KTaCl_6(KNbCl_6)-KAlCl_4-AlCl_3$. The melting diagrams for $TaCl_5-KCl-AlCl_3$ and $NbCl_5-KCl-AlCl_3$ were identical. (R.V.J.)

36379 DETERMINATION OF pH OF THE BEGINNING OF DISSOLUTION AND PRECIPITATION OF SCANDIUM HYDROXIDE BY MEANS OF A PHOTO-COLORIMETER. Kovalenko, P. N.; Bagdasarov, K. N. (Rostov-on-Don State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Khim. i Khim. Tekhnol., 6: 546-52(1963). (In Russian).

The isomolar series method was used to show that scandium and arsenaso formed a complex compound $Sc : Ars = 1 : 1$, with a molar coefficient of quenching of 6410, and a dissociation constant of 0.93×10^{-6}. It is shown that the pH of $Sc(OH)_3$ initial solubility and precipitation is almost identical (5.5 and 4.74). The activity of $Sc(OH)_3$ determined by the solid-phase dissolution method was 0.79×10^{-29} and by precipitation method was 1×10^{-29}. (R.V.J.)

36380 ATOMIC ENTROPY OF FORMATION OF INORGANIC SUBSTANCES AT HIGH TEMPERATURES. Kireev, V. A.; Kuibyshev, V. V. (Moscow Construction Inst.). Izv. Vysshikh Uchebn. Zavedenii, Khim. i Khim. Tekhnol., 6: 751-3(1963). (In Russian)

Tabulated data are given on the atomic entropy of ΔS^0_{form} formation of crystals for various elements and compounds at 1000°K and for gaseous substances at 1500°K. It was shown that at high temperature the ratios of ΔS^0_{form} for various substances are analogous to the ratios previously described at 25°C. (R.V.J.)

36381 VAPORIZATION OF TANTALUM CARBIDE−HAFNIUM CARBIDE SOLID SOLUTIONS. Deadmore, D. L. (National Aeronautics and Space Administration, Cleveland, Ohio). J. Am. Ceram. Soc., 48: 357-9(July 1965).

The vaporization rates in vacuum of hot-pressed HfC, TaC, and solid solutions of these carbides in the range from 2225 to 2725°C were determined by a Langmuir-type method. A composition near 80TaC·20HfC (mole %) exhibited the lowest vaporization rate of the compositions within this pseudobinary system. Variations in initial sample bulk density and vapor-specie condensation on the furnace wall had negligible effects on the measured vaporization rates. (auth)

36382 PREPARATION OF ULTRA-HIGH-PURITY SUBMICRON REFRACTORY OXIDES. Mazdiyasni, K. S.; Lynch, C. T.; Smith, J. S. (Wright-Patterson Air Force Base, Ohio). J. Am. Ceram. Soc., 48: 372-5(July 1965).

A method was developed for preparing ultra-high-purity submicron powders of refractory oxides from transition metal alkoxides. Compounds of the type $M(OR)_3$ and $M(OR)_4$, where R is an alkyl group such as C_4H_9– were thermally decomposed to oxides at 325 to 425°C at atmospheric pressure. Techniques were perfected to prepare, on a continuous basis, 99.95+% zirconia and hafnia with an average particle size of 100 to 200 Å. The fine-particle zirconia powder is cubic at room temperature and transforms completely to monoclinic when heated above 400°C. The powder densifies at a considerably lower temperature than commercial spectrographic-grade (99.9%) zirconia. (auth)

36383 UNIT CELLS OF THE MONAZITE-TYPE RARE-EARTH PHOSPHATES. Weigel, F.; Scherer, V.; Henschel, H. (Bundesministerium fuer Wissenschaftliche Forchung, Bad Godesberg, Ger.). J. Am. Ceram. Soc., 48: 383-4 (July 1965).

A series of rare earth phosphates was prepared by precipitation of the hydrated phosphates from an aqueous solution using stoichiometric amounts of $(NH_4)_2HPO_4$ as the precipitant, and ignition of the resulting precipitates for several hours at 1000°C. Powder patterns were obtained and lattice constants compared with those obtained by other authors. (M.C.G.)

36384 VAPOR PRESSURES OF BeF_2 AND NiF_2. Cantor, Stanley (Oak Ridge National Lab., Tenn.). J. Chem. Eng. Data, 10: 237-8(July 1965). (ORNL-P-881)

Manometric methods were used to measure the vapor pressures of BeF_2 and NiF_2. The measurements for BeF_2, taken in the temperature range, 872 to 1099°C, are given by $\log p(mm) = 10.487 - 10{,}967/T(°K)$. From this equation, the enthalpy of vaporization and extrapolated normal boiling point are: 50.2 kcal per mole and 1169°C. For NiF_2, measured between 1077 and 1283°C, the vapor pressures are given by $\log p(mm) = 11.385 - 14{,}860/T(°K)$. The NiF_2 had not melted at 1283°C. The calculated enthalpy of sublimation and extrapolated normal sublimation point are 68.0 kcal per mole and 1474°C. (auth)

36385 HEAT CONTENT AND HEAT CAPACITY OF AN EXTRUDED GRAPHITE FROM 341° TO 1723°K. McDonald, R. A. (Dow Chemical Co., Midland, Mich.). J. Chem. Eng. Data, 10: 243(July 1965).

The heat content of grade SPK graphite was measured between 341 and 1723°K. Smoothed values of enthalpy and heat capacity from 298 to 1800°K are given. (auth)

36386 VAPORIZATION AND SUBLIMATION OF $SrCl_2$. Loehman, Ronald E.; Kent, Richard A.; Margrave, John L. (Rice Univ., Houston, Texas). J. Chem. Eng. Data, 10: 296-7(July 1965).

The sublimation and vaporization rates of $SrCl_2$ were determined by means of the Langmuir and Knudsen techniques, respectively. The third-law heat of sublimation at 298°K is 78.6 ± 1.0 kcal $mole^{-1}$. (auth)

36387 PERTURBATION TREATMENT OF THE GROUND STATE OF He H^{++}. Matcha, Robert L.; Lyon, William D.; Hirschfelder, Joseph D. (Univ. of Wisconsin, Madison). I. Chem. Phys., 43: 1101-3(Aug. 15, 1965).

Rayleigh-Schrödinger perturbation calculations were carried out for the ground state of the HeH^{2+} molecular ion. The zero-order wavefunction is $\psi = N \exp(-\alpha Z_A r_A - \beta Z_B r_B)$. The expectation value of the Hamiltonian calculated with the wavefunction accurate through first order, E(1), was compared with the accurate series calculations of Bates and Carson and found to agree up to five places. Also the values of the normalized wavefunction accurate through the first order agreed with Bates and Carson, particularly for small values of the internuclear separation. (auth)

36388 AMIDE COMPLEXES OF THORIUM(IV) AND URANIUM(IV) IODIDES. Bagnall, K. W.; Brown, D.; Jones, P. J.; du Preez, J. G. J. Chem. Soc., 3594-8(June 1965).

The N,N-dimethylacetamide (DMA) complexes of thorium and uranium tetraiodide, ThI_4,6DMA and UI_4,4DMA, were prepared from the corresponding iodides. Uranium(IV) mixed halide complexes, UI_2Cl_2,5DMA and UI_3Cl,5DMA, were prepared from the chloride complex, UCl_4,2.5DMA. The last three compounds appear to be chlorine-bridged dimers in which the uranium is eight-covalent. (auth)

36389 UNSTABLE INTERMEDIATES. PART XXXI. SOLVATED ELECTRONS: SOLUTIONS OF EUROPIUM IN AMMONIA. Catterall, R.; Symons, M. C. R. J. Chem. Soc., 3763-70(June 1965).

The blue solution that results when europium metal dissolves in ammonia was studied by optical and electron spin resonance spectroscopy. It was found that dilute solutions can best be described in terms of europium(II) cations and solvated electrons. That separate spin resonance spectra can be observed for these two species led to the conclusion that they are well separated in the form of loose ion-pairs rather than as centrosymmetric units similar to the monomer described by others. (auth)

36390 NEPHALAUXETIC EFFECT IN THE RARE EARTH SULFIDES. Joergensen, Christian Klixbuell; Pappalardo, Romano; Flahaut, Jean (Cyanamid European Research Inst., Cologny, Switzerland and Faculte de Pharmacie, Paris). J. Chim. Phys., 62: 444-8(Apr. 1965). (In French)

The reflection spectra of the sulfides and double sulfides, trivalent Pr, Nd, Sm, Dy, Er, and Yb, and oxytellurides of Nd and Pr were measured at low temperature and discussed theoretically. The nephelauxetic effect was a little more pronounced than in the oxides and much stronger than in the anhydrous chlorides. (tr-auth)

36391 FILM FORMATION ON PYROLYTIC GRAPHITE ELECTRODES. Mamantov, Gleb (Univ. of Tennessee, Knoxville); Freeman, Donald B.; Miller, F. J.; Zittel, H. E. J. Electroanal. Chem., 9: 305-10(Apr. 1965). (ORNL-P-1024).

It was shown that electrochemical or chemical oxidation with a strong oxidant, such as Ce(IV), results in the formation of a film on the surface of pyrolytic graphite. The film produced anodically differs electrochemically from the film produced chemically, although in both cases reduction of the film was observed at ~ +0.5 v vs the saturated calomel electrode. The reduction of the film apparently proceeded irreversibly. Attempts to study the film by high voltage electron diffraction were unsuccessful. The nature of the film was not determined. (auth)

36392 RARE EARTH ACTIVATED PHOSPHORS BASED ON YTTRIUM ORTHOVANADATE AND RELATED COMPOUNDS. Palilla, Frank C.; Levine, Albert K.; Rinkevics, Maija (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). J. Electrochem. Soc., 112: 776-9(Aug. 1965).

The adoption of YVO_4:Eu as a new red-emitting primary in color television had stimulated investigation of a new class of phosphors obtained by appropriate substitutions in YVO_4:Eu. Substitution of Y^{3+} by Gd^{3+} and Lu^{3+} provided equally efficient hosts for Eu^{3+} with no significant spectral differences. Substitution of Y^{3+} by La^{3+} led to a less efficient host with important differences in the emission characteristics of Eu^{3+}. Use of rare earth activators other than Eu^{3+} provided a series of phosphors, which emit over most of the visible range. Spectral data and preferred concentration ranges are presented as well as the effect of temperature on the fluorescent emission intensities. (auth)

36393 LASER CHARACTERISTICS OF NIOBIUM COMPENSATED $CaMoO_4$ AND $SrMoO_4$. Flournoy, P. A.; Brixner, L. H. (E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.). J. Electrochem. Soc., 112: 779-81 (Aug. 1965).

The niobium-compensated $CaMoO_4$ and $SrMoO_4$ systems were found to be excellent host materials for rare earth ions. A discussion is given of pertinent crystal properties, fluorescence spectra, laser output wavelengths, thresholds for stimulated emission, and other parameters of importance in practical utilization of these materials for pulsed and CW lasers. A comparison with sodium-compensated $CaWO_4:Nd^{3+}$ is given where data are available. (auth)

36394 VACUUM DEPOSITED MOLYBDENUM FILMS. Holmwood, R. A.; Glang, R. (IBM Components Div., East Fishkill Facility, Hopewell Junction, N. Y.). J. Electrochem. Soc., 112: 827-31(Aug. 1965).

Vacuum evaporation of molybdenum with an electron bombardment source on oxidized silicon wafers produced films whose properties depended on the condensation temperature. At 600°C or above, the films had resistivities comparable to molybdenum wire, satisfactory adhesion, and tolerable stress. They were potentially useful as interconnections for silicon devices and monolithic circuits. All films were polycrystalline with (110) fiber texture. Other crystallite orientations appeared above 500°C, while simultaneously the intrinsic film stress became decreasingly tensile and, at 625°C, compressive. Film stress and preferred orientation were considered to result from the interaction of lattice defects during the entire growth process and not merely from lattice distortions at the film substrate interface. (auth)

36395 THE ELECTRODEPOSITION OF COHERENT DEPOSITS OF REFRACTORY METALS. II. THE ELECTRODE REACTIONS IN THE DEPOSITION OF TANTALUM. Senderoff, S.; Mellors, G. W.; Reinhart, W. J. (Union Carbide Corp., Parma, Ohio). J. Electrochem. Soc., 112: 840-5(Aug. 1965).

The reduction of pentavalent tantalum to tantalum metal in molten LiF–NaF–KF eutectic mixture was studied by chronopotentiometry between 650 and 850°C. It was a two-step reduction apparently involving a three-electron step followed by a two-electron step. The first step was diffusion controlled, and the diffusion coefficient of the reacting species was 1.5×10^{-5} cm^2 sec at 750°C and its activation energy 8.5 kcal/mole. (auth)

36396 PREFERENTIAL VAPORIZATION OF CARBON FROM HAFNIUM CARBIDE. Hansler, R. L. (General Electric Co., Cleveland, Ohio). J. Electrochem. Soc., 112: 881(Aug. 1965).

For hafnium carbide the rate of vaporization of carbon increased with temperature and with the amount of carbon in the carbide. It was clearly shown that carbon was preferentially lost from the hafnium carbide prepared by heating hafnium to ~2800°K in an atmosphere of argon containing about 5 Torr of methane. (F.J.H.)

36397 OBSERVATIONS ON THE RARE EARTHS—LXXVII. ANHYDROUS N,N-DIMETHYLACETAMIDE ADDUCTS OF THE TRI-POSITIVE PERCHLORATES. Moeller, T.; Vicentini, G. (Univ. of Illinois, Urbana and Universidade de Sao Paulo, Brazil). J. Inorg. Nucl. Chem., 27: 1477-82(July 1965).

Compounds of formulas $Ln(ClO_4)_3 \cdot 8DMA$ (Ln = La, Ce, Pr, Nd; DMA = N,N-dimethylacetamide), $Ln(ClO_4)_3 \cdot 7DMA$ (Ln = Y, Sm, Eu, Gd, Tb, Dy, Ho, Er), and $Ln(ClO_4)_3 \cdot 6DMA$ (Ln = Tm, Yb, Lu) were prepared by the reaction of hydrated lanthanide perchlorates with N,N-dimethylacetamide. The visible spectra of some of the compounds, the infrared spectra, and the x-ray powder patterns were determined. The compositions of these compounds appeared to reflect the increasing spatial constraint produced by decreasing cationic crystal radius as the atomic number of the lanthanide became larger. (auth)

36398 NON-STOICHIOMETRY IN NEODYMIUM AND EUROPIUM OXIDES IN RELATION TO THEIR INTERACTION WITH OXYGEN AND HYDROGEN. Barrett, M. F.; Barry, T. I. (National Chemical Lab., Teddington, Middlesex, Eng.). J. Inorg. Nucl. Chem., 27: 1483-87(July 1965).

Neodymium oxide had a small composition range on either side of stoichiometry. It is shown that oxygen diffusion and electrical conductivity are greater in the oxide with excess of oxygen than in that with a deficiency of oxygen, and that excess oxygen readily penetrated the small crystallites at temperatures as low as 350°C. Europium oxide could readily be partially reduced by hydrogen with no change in electrical conductivity. This reduced oxide was catalytically more active than Eu_2O_3 towards the reaction of hydrogen with oxygen. (auth)

36399 RARE-EARTH CARBONATES PREPARED BY HOMOGENEOUS PRECIPITATION. Charles, R. G. (Westinghouse Research Labs., Pittsburgh). J. Inorg. Nucl. Chem., 27: 1489-93(July 1965).

Rare earth carbonates were prepared by heating a water solution containing the rare earth chloride and ammonium trichloroacetate. Normal carbonates were obtained with La, Nd, Sm, Eu, Gd, Tb, Dy, and Ho while Ce, Pr, Er, Tm, Yb, and Lu gave basic carbonates under the same experimental conditions. Infrared absorption spectra of the solid products were sensitive to the degree of hydration and to the degree of basic character. The thermal decomposition of the products was examined by means of thermogravimetric analysis. (auth)

36400 THE REACTION OF RUTHENIUM(III) WITH NITRIC ACID. Fletcher, J. M.; Woodhead, J. L. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. Nucl. Chem., 27: 1517-19(July 1965).

In contrast to its behavior in solution in hydrochloric acid, ruthenium(III) in nitric acid slowly disproportionates giving 25% of the ruthenium as nitrosylruthenium(III) and 75% as the polynuclear form of ruthenium(IV). This reaction presented some analogies with the oxidation of ruthenium(III) by perchloric acid. (auth)

36401 THE CRYSTAL STRUCTURE OF BARIUM DIURANATE, BaU_2O_7. Allpress, J. G. (Univ. of Melbourne). J. Inorg. Nucl. Chem., 27: 1521-27(July 1965).

BaU_2O_7 is tetragonal, space group $I4_1/amd$, with a = 7.128 and c = 11.95 Å. The uranium atoms are in octahedral co-ordination, and linear uranyl groups are present. The octahedra were joined by sharing edges, and formed endless chains in the a and b directions. The main features of the infrared spectrum of this compound are discussed in terms of its structure. (auth)

36402 THE SEARCH FOR PERBROMATE. I. THE THERMAL DECOMPOSITION OF BROMATES. Bancroft, G. M.; Gesser, H. D. (Univ. of Manitoba, Winnipeg). J. Inorg. Nucl. Chem., 27: 1545-56(July 1965).

Thermograms of the seventeen bromates that were thermally decomposed in a newly constructed apparatus are presented. The bromates decomposed to the bromide and/or the oxide depending on the cation. Although the thermograms of strontium bromate provided some evidence for perbromate formation, this was disproved by DTA (differential thermal analysis) and infrared analysis. Relative free energies of decomposition and activation energies were calculated for the decompositions. The role of kinetics and thermodynamics in predicting the decomposition of bromates is discussed. (auth)

36403 THE EFFECT OF PHASE DISTRIBUTION ON THE HYDROLYSIS OF URANIUM MONOCARBIDE-DICARBIDE MIXTURES. Bradley, Mildred J.; Ferris, L. M. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 27: 1557-69(July 1965). (ORNL-P-599)

The hydrolysis of uranium monocarbide-dicarbide mixtures involves complex polymerization reactions between the single C units from the monocarbide and the C_2 pairs from the dicarbide, which depend on the distribution of the phases throughout the mixtures. The deviation in the hydrocarbon products from the values calculated for mono-

carbide-dicarbide binaries was proportional to the amount of monocarbide adjacent to dicarbide in the crystal. A physical mixture with no adjacent monocarbide and dicarbide behaved like a monocarbide-dicarbide binary; as-cast mixtures, which have very fine platelets of mono-and dicarbide dispersed uniformly throughout the crystal, showed maximum deviation; while 1820 to 2130°C heat-treated mixtures with relatively large isolated areas of monocarbide and dicarbide within the crystal but still considerable contact between the phases exhibited intermediate properties. (auth)

36404 CHARGE TRANSFER SPECTRA IN AQUEOUS SOLUTIONS OF THE ACTINIDE ELEMENT IONS. Miles, J. H. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. Nucl. Chem., 27: 1595-1600(July 1965).

The relationship between the wavelength of the ultraviolet edge of the spectra of variable valency metal ions, and the potential of the appropriate redox couple, was previously demonstrated on the transition element series. It was demonstrated for the actinide element ions, in the (III), (IV), and (VI) valency states. The charge transfer assignments made were confirmed by results on the initiation of polymerization of acrylonitrile in uranium ion solutions. They were also consistent with literature data on the effect of acid concentration on the spectra. Values of −3.25 and +2.4 v may be estimated for the formal potentials of the Cm(III)/Cm(IV) and Th(III)/Th(IV) couples, and it may be predicted that the spectrum of Bk(III) will show an ultraviolet edge at 2300 Å. (auth)

36405 LANTHANIDE COMPLEXES. II. COMPLEXES OF 1:10-PHENANTHROLINE WITH LANTHANIDE ACETATES AND NITRATES. Hart, F. A.; Laming, F. P. (Queen Mary Coll., London). J. Inorg. Nucl. Chem., 27: 1605-10(July 1965).

Crystalline, thermally stable complexes of the types $M(CH_3COO)_3(phen)$ and $M(NO_3)_3(phen)_2$, where M = all the lanthanides except Pm and phen = 1:10-phenanthroline, were isolated. Magnetic moments and infrared spectra are reported and structures are discussed. (auth)

36406 THE STABILITIES AND THERMODYNAMIC PROPERTIES OF THORIUM(IV) AND ZIRCONIUM(IV) CHELATES OF TRANS-1,2-DIAMINOCYCLOHEXANE-N,N,N′,N′-TETRAACETIC ACID (H_4DCTA). Hseu, Tong-Ming, Wu, Shiou-fu; Chuang, Tung-jong (National Taiwan Univ., Taipei, Republic of China). J. Inorg. Nucl. Chem., 27: 1655-62(July 1965).

The interaction between trans-1,2-diaminocyclohexane-N,N,N′,N′-tetraacetic acid (H_4DCTA or H_4Z) and Th(IV) and Zr(IV) ions was investigated potentiometrically by using a mercury indicator electrode. The formation constants of the chelates ThZ and ZrZ were evaluated at a constant ionic strength of 0.10 (KNO_3) at 10, 20, and 30°C. Enthalpy and entropy changes characterizing the formation of the chelates were calculated at 25°C. The results are given. (auth)

36407 FLUORINATION OF URANIUM COMPOUNDS BY BROMINE TRIFLUORIDE VAPOR. I. FLUORINATION OF U_3O_8. Iwasaki, Matae; Sakurai, Tsutomu (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 225-8(June 1965).

The fluorination of U_3O_8 powder by BrF_3 vapor was attempted. The reaction proceeded even at 67°C and under 10 mmHg BrF_3 partial pressure, producing UF_6. The reaction rate increases with temperature up to about 220°C, and its activation energy is 0.9 kcal/mol. The reaction rate, however, decreases at temperatures slightly above 220°C and rises again after passing through a minimum at 225° ~ 230°C. (auth)

36408 ON DICYCLOPENTADIENYLEUROPIUM AND DICYCLOPENTADIENYLYTTERBIUM AND THE TRICYCLOPENTADIENYLS OF TERBIUM, HOLMIUM, THULIUM, AND LUTETIUM. Fischer, Ernst Otto; Fischer, Hartmut (Universitaet, Munich). J. Organometal. Chem. (Amsterdam), 3: 181-7(Mar. 1965). (In German)

A solution of Eu in liquid ammonia is treated with cyclopentadiene, yielding a clear yellow solution. Evaporation of the solvent gives a yellow product which loses ammonia in high vacuum above 120°C and sublimes at 400−420°C, giving dicyclopentadienyleuropium. The reaction in ammonia proceeds with formation of cyclopentene. The organometallic is unstable to oxygen and water, is insoluble in hydrocarbons and the usual ethers, but soluble in dimethylformamide and water; it is paramagnetic, with $\chi_{mol}^{300°K} = (24{,}600 \pm 1{,}100) \times 10^{-6}$ cm³/mol; $\chi_{mol}^{80°K} = (88{,}800 \pm 4{,}600) \times 10^{-6}$ cm³/mol; $\mu_{eff} = (7.63 \pm 0.17)$ B. M. Dicyclopentadienylytterbium may be prepared analogously and has $\chi_{mol}^{300°K} = (-90 \pm 20) \times 10^{-6}$ cm³/mol. The ir spectra are similar and indicate a saltlike character. The Eu compound crystallizes like the Sr, but the Yb differs from the Ca. The tricyclopentadienyls of Tb, Ho, Tm, and Lu were also prepared and have the following color, mp, $\chi_{mol}^{300°K}$ ($\times 10^{-6}$ cm³/mol), $\chi_{mol}^{80°K}$ ($\times 10^{-6}$ cm³/mol), and μ_{eff} (B.M.), respectively: colorless, yellow, greenish yellow, colorless; 316, 295, 278, 264°C; +33,500, +44,700, +21,800, −190; +114,000, +148,000, +69,000, --; 8.9, 10.2, 7.1, --. The ir spectra are similar. The rings are symmetrical and the metal bond polar but not completely electrostatic. The NMR spectrum of the Lu compound is reported; this also has $\mu = 0.86$D. (BBB)

36409 ISOTOPE EFFECTS AS TOOLS FOR THE ELUCIDATION OF REACTION MECHANISMS: PREDICTIONS FROM MODEL CALCULATIONS. Stern, Marvin J.; Wolfsberg, Max (Columbia Univ., New York). J. Pharm. Sci., 54: 849-58(June 1965). (BNL-8768)

A discussion is given of the nature of isotope effects and some predictions are made from model calculations concerning how to interpret experimentally observed effects. These calculations, based on the statistical-mechanical formulation of isotope effects, can be used to predict how analyses of experimentally measured isotope effects may be used to gain information on differences between the reactants and the transition state in a rate process or between the reactants and the products in an equilibrium process. Isotope effects, other than $V_{1L}^{\ddagger}/V_{2L}^{\ddagger}$ (the isotopic ratio of the zero or imaginary frequencies of the transitional state), at room temperature and above are extremely small unless there is a force constant change at the isotopic position. Isotope effects, therefore, may be used as probes for such changes and thus for participation in reaction mechanisms. Measurement of the temperature dependence of an isotope effect and the use of different isotopic substitutions in the same molecule may help determine or place limits on the particular force constant changes occurring between reactants and transition state. Secondary heavy-atom isotope effects may give information about the decomposition motion in a transition state. For pharmacologic applications calculations were made showing that isotope effects for very large molecular systems may be studied theoretically by using smaller molecules in the calculations. It appeared that large changes in, or even complete omission of, all parts of the molecules more than two bonds removed from the isotopic position(s) will not affect appreciably the calculated values of $(k_1/k_2)/(V_{1L}^{\ddagger}/V_{2L}^{\ddagger})$, where k_1/k_2 is the isotopic rate-constant ratio. In some cases, this cut-off procedure may be carried one bond closer, but only with considerable caution. (BBB)

36410 THE MEASUREMENT OF SMALL SURFACE AREAS BY THE B.E.T. ADSORPTION METHOD. Chènebault, P. (Service de Chimie des Solides, Grenoble, France); Schuerenkaemper, A. J. Phys. Chem., 69: 2300-5(July 1965).

It was possible to measure surface areas of the order of a few square centimeters by using a mixture of natural xenon and ^{133}Xe as the adsorbate. The vapor tension of xenon at the temperature of liquid nitrogen was equal to 2.15×10^{-3} mm. The surface measured for glass was equal to the geometrical surface of the samples. In the case of sintered uranium dioxide samples of different densities, the lower the density, the greater the surface area. (auth)

36411 FLUORINE BOMB CALORIMETRY. XI. THE ENTHALPY OF FORMATION OF YTTRIUM TRIFLUORIDE. Rudzitis, Edgars; Feder, Harold M.; Hubbard, Ward N. (Argonne National Lab., Ill.). J. Phys. Chem., 69: 2305-7(July 1965).

The energy of formation of yttrium trifluoride was measured by direct combination of the elements in a bomb calorimeter. The standard enthalpy and Gibbs free energy of formation at 298.15°K were determined to be -410.7 ± 0.8 and -393.6 ± 1.0 kcal mole^{-1}, respectively. (auth)

36412 FLUORINE BOMB CALORIMETRY. XII. THE ENTHALPY OF FORMATION OF RUTHENIUM PENTAFLUORIDE. Porte, Howard A.; Greenberg, Elliott; Hubbard, Ward N. (Argonne National Lab., Ill.). J. Phys. Chem., 69: 2308-10(July 1965).

The energy of formation of ruthenium pentafluoride was measured by direct combination of the elements in a combustion bomb calorimeter. The standard enthalpy of formation, $\Delta Hf^{\circ}_{298.15}$, was calculated to be $-213.4_1 \pm 0.3_5$ kcal mole^{-1}. (auth)

36413 KINETICS OF URANYL ION HYDROLYSIS AND POLYMERIZATION. Whittaker, M. P.; Eyring, E. M.; Dibble, E. (Univ. of Utah, Salt Lake City). J. Phys. Chem., 69: 2319-23(July 1965).

Temperature jump relaxation times were observed in acidic, aqueous solutions of uranyl ion that were identified with the equilibrium $2UO_2^{2+} + 2H_2O \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} (UO_2)_2(OH)_2^{2+} + 2H^+$. The rate constant k_2 at 25° was found to have the value 116 M^{-1} sec^{-1}. This result was compared with the dimerization of chromate and vanadate ions. (auth)

36414 ON THE EFFECT OF THE DOUBLE-IMPACT COLLISION ON DISSOCIATION RATE CONSTANTS. Shin, H. (Univ. of Nevada, Reno). J. Phys. Chem., 69: 2411-14(July 1965).

The effect of double-impact collisions on the dissociation rate constant of the collision system RA + B, where RA was a molecule and B was an incident particle was studied by calculating the probability of the momentum transfer between the collision partners. When the masses of the system satisfy $m_B/m_R = (m_A/m_R + 1)/(m_R/m_A - 1)$, the exact analysis of the impact process between A of RA and B and, in turn, the explicit formulation of the transition probability were found to be possible. Relatively few energetic particles that just missed the second impact with the molecules predominantly controlled the magnitude of the rate constant. (auth)

36415 THE HEAT OF FORMATION OF LANTHANUM OXIDE. Fitzgibbon, George C. (Los Alamos Scientific Lab., N. Mex.); Holley, Charles E. Jr.; Wadsoe, Ingemar. J. Phys. Chem., 69: 2464-9(July 1965). (LA-DC-6826)

The heat of formation of lanthanum oxide was calculated. The values agreed with each other within the estimated uncertainties and they both agreed with the combustion value, -428.57 ± 0.19 kcal/mole, obtained by Huber and Holley. The weighted average of the three sets of measurements was -428.6 ± 0.2 kcal/mole. The heat of formation of hexagonal La_2O_3 can be regarded as determined to within rather narrow limits (about 0.1%) by two independent methods. (F.J.H.)

36416 ISOTOPIC EQUILIBRIUM SEPARATION FACTORS IN THE HYDROGEN SOLUBILITY PROCESS IN PLATINUM–PALLADIUM ALLOYS. Botter, F. (Centre d'Etudes Nucleaires, Saclay, France). J. Phys. Chem., 69: 2485-7(July 1965).

Using an alloy of appropriate palladium-platinum ratio, the respective separate equilibrium solubilities of hydrogen and deuterium may be as high as 15:1(25°C). A separation of 10 to 15 was obtained by means of electrochemical experiments. In the isotherm obtained on Pt–Pd preparation, the plateau of the two-phase $\alpha \rightleftharpoons \beta$ region completely disappeared, which was proof that an alloy was obtained. The separation factor α was measured at −78, 20, and 82°C under atmospheric total pressure, using both a chromatographic technique with 75% deuterium-enriched hydrogen and single-stage equilibrations of hydrogen of natural abundance (130 ppm of deuterium as 260 ppm of (HD)/(HD + D_2)) with subsequent mass spectrometric analysis. The following equilibria have to be considered, H_2(gas) + D(Soln) $\rightleftharpoons$ HD(gas) + H(Soln) $K_1 = 2\alpha$, which takes place almost exclusively for a low deuterium abundance; HD(gas) + D(Soln) $\rightleftharpoons$ D_2(gas) + H(Soln) $k_2 = \alpha_2/2$, which prevails for very high deuterium content, and H_2(gas) + 2D(Soln) $\rightleftharpoons$ D_2(gas) + 2H(Soln) $k_3\alpha_1\alpha_2$ H_2(gas) + D_2(gas) $\rightleftharpoons$ 2HD(gas) $k_4 = k_1/k_2 = 4\alpha_1/\alpha_2$, H_2(gas) $\rightleftharpoons$ 2H(Soln) k_5, and D_2(gas) $\rightleftharpoons$ 2D(Soln) k_6. The k's represent the equilibrium constants; α_1 and α_2 were the isotopic separation factors for low concentration range and high concentration range, respectively. (F.J.H.)

36417 MEASUREMENT OF GASEOUS THERMAL DIFFUSION FACTOR BY TRENNSCHAUKEL. Joshi, R. K.; Saxena, S. C. (Rajasthan Univ., Jaipur). J. Sci. Ind. Res. (India), 24: 21-30(Jan. 1965).

A device for multiplying the elementary two-bulb separation for thermal diffusion measurements known as the "Trennschaukel" or "swing-separator" was studied. The swing-separator consists of a number of identical suitable size vertical tubes arranged such that the bottom of one tube is suitably connected with the top of the next tube by a capillary of suitable bore. The top of the first tube is connected to the bottom of the last tube via a gas pump. The various criteria that can lead to the ideal operation of a trennschaukel were derived. The correction factors, which appear because of the non-fulfilment of the ideal geometry required were calculated. The relaxation time, decay in amplitude of the gas swing towards the central tube, decrease in separation due to thermal diffusion in the capillaries, and enhancement in separation due to mass displacement of the gas are discussed. (M.C.G.)

36418 ISOTOPIC EFFECT IN THE FERROELECTRIC $NaH_3(SeO_3)_2$. Gavrilova-Podol'skaya, G. V.; Yudin, A. L.; Lundin, A. G. (Inst. of Physics, Academy of Sciences, Siberian SSR). JETP Letters (USSR) (English Transl.), 1: 22-4(Apr. 1, 1965).

Since the nature of the spontaneous polarization of sodium hydroselenite can be explained by studying the effect when hydrogen is replaced by deuterium, such a study is made. It is a study of the temperature dependence of the dielectric constant of powdered samples of $NaD_3(SeO_3)_2$. It is found that the shift of the Curie point is of the same order of magnitude when the hydrogen is replaced in the hydroselenite by deuterium as that other ferroelectrics. (J.F.P.)

36419 FLUORESCENT PROPERTIES OF TRIVALENT NEODYMIUM IN LANTHANUM AND YTTRIUM ORTHONIOBATES AND TANTALATES. Wesselink, G. A.; Bril, A. Philips Res. Rept., 20: 269-77(June 1965).

Data on the efficiencies, excitation spectra, diffuse-reflection spectra, emission spectra, and decay times are given for some neodyminum-activated lanthanum and yttrium niobates and tantalates. The quantum efficiencies of the niobates are comparable to those of neodymium-activated calcium tungstates. These phosphors have properties that make them suitable as laser materials. (auth)

36420 VAPORS OF THE ELEMENTS. Siegel, Bernard (Aerospace Corp., El Segundo, Calif.). Quart. Rev. (London), 19: 77-94(1965).

Because of the different pressure-temperature relationships for the various non-volatile elements, their equilibrium vapor pressures at any given temperature vary widely and this affects strongly the degree of dissociation at any specific temperature. Bonding in homonuclear molecules observed at high temperature is discussed for the elements in groups IA, IIA, IIIB, IVB, VB, and VI. (F.J.H.)

36421 COMPLEX FORMATION OF LANTHANUM WITH α-AMINO ACIDS. Kriss, E. E. (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 31: 328-32(1965). (In Russian)

The stability constants of compounds of lanthanum with

α-amino acids were determined. The α-amino acids studied with the potentiometric method were proline, valine, methionine, serine, histidine, cysteine, aspartic acid, and glutamic acid. It was shown that for amino acids not having supplementary functional groups, the relation between the logarithm of the stability constant and the reciprocal logarithm of the dissociation constant of the amino groups is linear. In the case of aspartic and glutamic acids having supplementary carboxyl groups, the linear relationship was disturbed apparently because of the interaction of lanthanum with this group. It was shown that in the series of amino acids investigated the greatest stability was processed by compounds of lanthanum with aspartic and glutamic acids. (tr-auth)

36422 GLUCONATE COMPLEXES OF SCANDIUM. Kostromina, N. A.; Romanenko, E. D. (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 31: 332-8(1965). (In Russian)

The stability constants of the complexes $ScGH_4^{2+}(\beta_1)$ and $Sc(GH_4)_2^{+}(\beta_2)$ and the acid dissociation constant of the complex $ScGH_4^{2+}(K)$, where GH = gluconic acid, were determined for different ionic salts by potentiometric titrations. The following values were obtained: $lg\beta_1 = 3.97 \pm 0.14$; $lg\beta_2 = 7.05 \pm 0.05$; and $pK_0 = 4.35 \pm 0.12$. (tr-auth)

36423 EUROPIUM SULFIDES. Radzikovskaya, S. V. (Inst. of Study of Materials, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 31: 635-6(1965). (In Russian)

Europium sulfides, instead of Eu_2O_3, were produced by reacting europium oxide with hydrogen sulfide at 1000 to 1100°C. The starting europium oxide was 99.0% pure. The oxide powder sample was heated in a tube furnace through which H_2S was continuously passed at a rate of ~0.1 l/min. The reaction products were subjected to chemical and x-ray analysis. The content of europium was determined by the conventional oxalate method. The sulfur was determined by sulfide combustion in an oxygen stream at 1200°C followed by alkalimetric analytical reaction. The monosulfide is a black powder which dissolves poorly in acids. X-ray diffraction analysis of structure and lattice constants gave values in close agreement with literature values. (ATD)

36424 NORMAL COORDINATE ANALYSIS OF U(V)F_6^- IN THE UREY-BRADLEY FIELD. Yeranos, Walter A. (Northern Illinois Univ., DeKalb). Z. Physik. Chem. (Frankfurt), 45: 72-6(Apr. 1965).

Infrared data were used to determine the force constants of UF_6^- in the Urey-Bradley, as well as a modified Urey-Bradley fields. The vibrational analysis was carried within Wilson's G−F matrix method and the force constants were evaluated by the use of a computer program coded specifically for the IBM 1620 II. The program refines the differences of the experimental and calculated frequencies in the least squares sense and better fits were obtained by the inclusion of interaction force constants involving trans bond stretches and adjacent angle-bends. The normal coordinates as well as the potential energy distribution of UF_6^- are reported. (auth)

36425 ON THE THEORY OF THE VIBRATIONAL STRUCTURE OF PARAMAGNETIC CRYSTAL OPTICAL SPECTRA. Malkin, B. Z. (Kazan State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 48: 1637-45(June 1965). (In Russian)

Single-phonon electron-vibrational transitions in ionic crystals containing impurity elements of the transition groups are considered. The vibrational structure of the luminescence spectrum of the $CaF_2:Tm^{2+}$ crystal is computed theoretically. Comparison with the experiments confirms the presence of a vibrational structure of the lines due to quasi-local vibrations. The possibility of studying the dynamics of an impurity crystal by optical spectroscopy is discussed. (auth)

36426 PREPARATION OF RARE EARTH SELENIDES BY SELENITE REDUCTION. Markovskii, L. Ya.; Soboleva, M. S.; Sapozhnikov, Yu. P. (State Inst. of Applied Chemistry, USSR). Zh. Prikl. Khim., 38: 717-20(Apr. 1965). (In Russian)

It was shown that the polyselenides of La, Ce, Pr, Nd, Sm, and Gd with a minimum percentage of oxide compounds can be comparatively easily prepared by the reduction of selenite salts with hydrogen mixed with hydrogen selenide at temperatures considerably lower than those used for the selenization of the oxide. The results of the experimental studies made it possible to assume that the method given can be used for the production of the selenides of other rare earth elements. In the case of the utilization of primary selenite salts of high purity, the method can be used for the production of selenides of the rare earths suitable for semiconductor and luminescence techniques. (tr-auth)

36427 CALCULATIONS OF THE FIELD OF ELECTROSTATIC FOCUSING SYSTEM AND MODELING IN ELECTROLYTIC BATH. Dymovich, V. I.; Sysoev, A. A. p.27-32 of "Fizicheskaya Elektronika. Vypusk 2." Moscow, Atomizdat, 1965. (In Russian)

An equation is given for the electric field of an electrostatic focusing system (efs), and its solution is developed mathematically. The effect of changing the potentials of the electrodes on the potential at a given point in the axially symmetrical efs system was studied in an electrolytic bath with a sloping bottom. Equipotential surfaces were determined and recorded, an oscillograph being used to measure zero points. The precision of measurement was ±0.05 mm. Curves are given for the experimentally determined dependence of the changes in the lowering of the zero equipotential surface on the electrode potential changes. The data show that with increase in the number of the electrode, its contribution to the change in the lowering of the zero equipotential surface decreases asymptotically. In the study the not entirely valid assumption was made that with change in the lowering, the zero equipotential surface in the zero plane has its former zero coordinate. (TTT)

36428 THE ATOMIC MASSES OF THE STABLE ISOTOPES OF THE ELEMENTS FROM GALLIUM THROUGH MOLYBDENUM. Ries, Richard Ralph. Thesis, Minneapolis, Univ. of Minnesota, 1963. 145p.

The large double-focusing mass spectrometer at the University of Minnesota was used to measure the masses of all 42 stable atoms from Z = 31 to 42 and A = 69 to 100 to an accuracy of about five parts in 100 million. Comparisons are made between the present results and previous measurements by this and other laboratories. Whenever possible, computed and directly measured mass differences are also compared with nuclear reaction mass differences. A least squares adjustment was performed on the raw data whenever it was possible to make more than one independent measurement on a given isotope. From the stable masses determined in this investigation and the available nuclear reaction and β-decay energies, atomic masses for 65 radioactive isotopes were calculated. Combining the stable and radioactive masses results in an atomic mass table of 107 isotopic masses covering the region from A = 67 to A = 100. These atomic masses are then used to compute the total nuclear binding energy of many nuclei in the above range of A. Such a list of total nuclear binding energies enables one to calculate the binding energy of various groups of particles in many nuclei in this region. For example, the binding energy of the last or least bound neutron and proton, and the least bound pair of nucleons have been calculated for all values of Z and N wherever the calculation is possible. According to the shell theory of the nucleus proposed by Mayer and others, these quantities should become anomalous for those values of Z or N at a magic number. The shell closing at 50 neutrons was studied in this work, and the above-mentioned anomalous behavior was once again verified. Some evidence also seems to indicate the presence of a possible sub-shell at Z and N = 40. (A.G.W.)

36429 COLLOIDAL PARTICLES, SOLS CONTAINING THEM AND PROCESSES FOR THE PREPARATION THEREOF. (to W. R. Grace and Co.). British Patent 988,982. Apr. 14, 1965. Priority date Dec. 5, 1962, United States.

A method is described for the preparation of a colloidal

sol in which the particles consist of an actinide oxide, particularly urania, intimately associated with zirconia and having an actinide oxide : zirconia weight ratio of 5 : 1 to 1 : 1. The solid content of the sol is about 5%, and the diameter of the particles is in the range of 3 to 9 mμ. The sol is prepared by the electrodialysis of a mixed solution of uranyl and zirconyl chlorides under a nitrogen atmosphere at a temperature of about 40 to 120°C. The electrodialysis is continued until the specific conductance is reduced to 10^{-2} to 3×10^{-4} mhos/cm, and the pH is about 2.5 to 4.5. The resulting sols can be concentrated to about 20 wt % solids by vacuum evaporation. (B.L.M.)

36430 METHOD FOR THE PRODUCTION OF BORON NITRIDE. Wood, Anthony Arthur Robinson; Shears, Eric Campbell (to United States Borax and Chemical Corp.). German Patent 1,193,020. May 20, 1965. Priority date Mar. 24, 1958, [United States].

Boron nitride was prepared by passing nitrogen or ammonia over a mixture of boron oxide, boric acid, or a compound decomposing into boron oxide at a temperature between 1200 and 1600°C in the presence of a catalyst such as MoO_3, Cr_2O_3, Nb_2O_5, or of a mixture of $BaCO_3$ and MnO_2. The mixture obtained was treated with diluted mineral acids, and the boron nitride separated. (Gmelin Inst.)

36431 METHOD FOR PREPARING URANIUM DIOXIDE. Rokuo Ukaji and Hiroyuki Wada (to Osaka Kinzoku Kogyo Company, Limited). U. S. Patent 3,179,491. Apr. 20, 1965. Filed Feb. 20, 1962.

A method and apparatus are described for preparing UO_2 containing less than 0.01 wt % fluoride calculated as UO_2F_2. Uranium hexafluoride and a mixture of excess steam and hydrogen are introduced simultaneously into the upper portion of an elongated vertical reaction vessel of circular cross section. The UF_6 and the steam-hydrogen mixture are introduced tangentially through separate pipes at about 500°C. The incoming streams are introduced in opposing directions and form a spiral type movement in the reactor to facilitate the contact reaction. The product gases are removed from the top of the reaction vessel, and the product UO_2 is removed at the bottom. (B.L.M.)

36432 PROCESS FOR PREPARING URANOUS OXIDE SOLS. Smith, Jean G.; Fitch, Frederick T. (to W. R. Grace and Co.). U. S. Patent 3,189,555. June 15, 1965. Filed Feb. 28, 1962.

In a process for preparing aqueous dispersions of uranous oxide particles in the size range of 10–300 mμ, a solution of uranyl chloride is prepared, and the uranyl chloride is reduced to uranous oxychloride. The uranous oxychloride solution is autoclaved at 100–200°C for periods of 2–40 hr. The sol is then recovered by conventional techniques and dispersed in deionized water. (A.G.W.)

36433 PRODUCTION OF URANIUM DIOXIDE. Lloyd, James Elgie; Brooks, Lionel Hepworth (to United Kingdom Atomic Energy Authority). U. S. Patent 3,192,010. June 29, 1965. Priority date June 13, 1961, Great Britain.

Uranium dioxide having a high reactivity toward HF is produced by hydrating UO_3 by mixing it in powder form with water at about 80° C, maintaining the paste so formed at about 80° C until a dry granular solid of hydrated UO_3 is produced and dehydrating and reducing the hydrate UO_3 to give UO_2. Preferably the UO_3 powder is mixed with the water at high speed for about 20 min. An amount of water slightly in excess of the stoichiometric amount required for forming UO_3 dehydrate is used. (A.G.W.)

36434 PROCESS FOR PREPARING ZIRCONIUM OXIDES. Klimaszewski, Irvin C. (to Pittsburgh Plate Glass Co.). U. S. Patent 3,193,346. July 6, 1965. Filed Mar. 6, 1962.

In a process for preparing zirconium oxide from a solution of zirconyl nitrate in nitric acid, the solution is concentrated in an evaporator to precipitate some solid zirconyl nitrate. The resultant slurry is filtered, the mother liquor is recycled to the evaporator, and the solid zirconyl nitrate is calcined to zirconium oxide. Fine zirconium oxide dust leaving the calcining kiln in the vent gases is recovered by scrubbing in a jet condenser and fed back to the filter feed tank containing the zirconyl nitrate slurry. Nitrogen oxides in the kiln vent gases are removed in a scrub tower and the recovered nitric acid is reused. (A.G.W.)

Organic Chemistry

36435 (BNWL-SA-213) INTRAMOLECULAR HYDROGEN BONDING TO π-ELECTRONS IN SUBSTITUTED PHENOLS. Kéder, W. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 2, 1965. Contract AT(45-1)-1830. 8p. (CONF-650613-3) Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From American Chemical Society, 20th Northwest Regional Meeting, Corvallis, Ore.

Evidence is presented which show that the intermediate OH-stretching frequency in the infrared spectrum of 4-sec-butyl-2(α-methylbenzyl)-phenol (BAMBP) is due, not to intermolecular dimer formation, but to intramolecular hydrogen bonding to the π-electrons of the o-benzyl group. The OH-stretching spectra of BAMBP, p-dodecylphenol (DDP), and o- and p-phenylphenols in CCl_4 are compared. The effects of benzene on the spectra of DDP and BAMBP in CCl_4 are discussed. (D.L.C.)

36436 (ORNL-P-1366) INFRARED SPECTROSCOPIC STUDY OF CONDENSED PHASE TRANSITION IN CF_4. Steinhardt, Ralph G. Jr.; Neilsen, Walter (Hollins Coll., Va.); Morgan, Henry W.; Staats, Percy (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 22p. (CONF-650630-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Society of Physical Chemistry, 15th Annual Meeting, Paris.

Significant features of the infrared spectrum of CF_4 was studied from 112°K in the liquid state to approximately 20°K in the solid state. The fundamental absorption ν_4 and the combination bands ($\nu_2 + \nu_4$) and ($\nu_1 + \nu_4$) show strong discontinuities in band-width at the second-order transition near 76°K, but display no observable change in band-width at the melting point. Furthermore, the band ($\nu_1 + \nu_4$) displays apparent rotational fine structure in the liquid state as well as in the solid state above the transition temperature, but does not show fine structure at temperatures below the transition temperature. These observations appear to confirm directly the notion that the second-order transition involves the onset of restricted or hindered molecular rotation, and that the melting process involves primarily the destruction of the long-range order characteristic of the solid state. (auth)

36437 A CENTERED HYDROGEN BOND IN POTASSIUM HYDROGEN CHLOROMALEATE: A NEUTRON DIFFRACTION STRUCTURE DETERMINATION. Ellison, R. D.; Levy, H. A. (Oak Ridge National Lab., Tenn.). Acta Cryst., 19: 260-8(Aug. 10, 1965). (ORNL-P-730)

The crystal structure of potassium hydrogen chloromaleate was directly determined from three-dimensional neutron diffraction data by means of the Patterson synthesis. The nearly plane anion has a ring structure with a 2.40 Å O ... H ... O bridge in which the hydrogen atom is effectively centered. (auth)

36438 AFFINITY OF ORGANIC COMPOUNDS FOR FREE ELECTRONS WITH THERMAL ENERGIES. Zlatkis, Albert; Lovelock, J. E. (Univ. of Houston, Tex.). Clin. Chem., 11: 259-69(Feb. 1965).

A method for measuring the cross-section for electron absorption and the electron affinity of organic compounds is described, as well as its physical basis, scope, and limitations. The relative absorption cross-sections for organic compounds, including those of biologic interest, are also discussed. Most of the observations reported were made using electrons of thermal energies: electrons in thermal equilibrium with inert carrier gases over the temperature range 20 to 200°C. The attachment of electrons

to molecules can be observed with a simple ionization chamber, such as an argon or a cross-section ionization detector. If such a chamber contains only an inert gas and a source of ionizing radiation a small applied potential is sufficient to collect all of the ions liberated by the primary radiation. The dimensions and materials of construction of a simple plane parallel ion chamber, which has been found suitable for operation either by the d-c or the pulse method, are shown. The best results were obtained when the source of primary ionization was soft radiation from a metal foil coated with a layer of tritium-containing compound. A radiation source of sufficient intensity to provide a d-c saturation current of three times 10^{-9} to 10^{-8} amp is required. For d-c operation helium, hydrogen, or nitrogen, preferably the latter, may be used as the carrier gas. For the pulse method of operation, argon containing 5% methane is needed. The detector may be used at any temperature up to 200°C. The relative absorption coefficients for thermal electrons of different compounds are listed, relative to that of chlorobenzene which is assigned the value of unity. With few exceptions the substances so far found to possess large cross-sections for the absorption of thermal electrons are either important intermediates or coenzymes in the energy transfer processes of the living cell or else are substances toxic to these biologic processes. This suggests the possibility that the electron-absorbing intermediates and coenzymes of the energy-transfer process of the living cell function as an ordered sequence of reversible electron traps. (TCO)

36439 SYNTHESIS OF S^{35}-p-TOLUENE SULPHONIC ANHYDRIDE (TOSAN) OF HIGH SPECIFIC ACTIVITY. Thuneberg, L. (University Institute for Experimental Medicine, Copenhagen). Intern. J. Appl. Radiation Isotopes, 16: 413-18(July 1965).

A method is presented for the semi-micro scale sulfonation of toluene with concentrated ^{35}S sulfuric acid as the sulfonating agent and thionyl chloride as water-removing agent. Carried out at a temperature of 110°C, the sulfonation yielded a mixture of approximately 85% p-toluene sulfonic acid and 15% o-isomer; 95% of the sulfuric acid reacted without formation of sulfones. The mixture of isomers was converted quantitatively to the corresponding acid chlorides by reaction with thionyl chloride. Chromatographically pure p-toluene sulfonic acid chloride with a melting point of 69 to 69.5°C was obtained in 75 to 80% yield by repeated recrystallizations from heptane. The p-toluene sufonic acid was produced in equal yields by hydrolysis with boiling water. Conversion to the sulfonic anhydride was effected either by reaction with thionyl chloride or, better, by means of N,N-di-(p-tolyl)-carbodiimide. A reproducible overall yield of pure p-toluene sulfonic anhydride (tosan), mp 127 to 129°C, of 60 to 70% based on the sulfuric acid, was obtained. (auth)

36440 SECONDARY α-DEUTERIUM ISOTOPE EFFECTS AND RELATIVE RATES IN THE HALOGEN EXCHANGE REACTIONS OF BENZYL AND THENYL CHLORIDES. Oestman, Boerje (Brookhaven National Lab., Upton, N. Y.). J. Am. Chem. Soc., 87: 3163-7(July 20, 1965). (BNL-8465)

The secondary deuterium isotope effects were found to be approximately the same for the isotopic halogen exchange reactions of $ArCD_2Cl$ where Ar = phenyl, 2-thienyl, or 3-thienyl. The reactivity of the compounds was found to be in the order 2-thienyl > phenyl > 3-thienyl. MO calculations with a pd^2-hybridized thiophene model are shown to give acceptable agreement with the rate constant ratios found experimentally. Comparisons with the relative reactivities in the hydrogen exchange of benzene and thiophene were made. (auth)

36441 THE INTEGRATED ABSORPTION INTENSITY OF THE C=O STRETCHING BAND OF CARBON-13-LABELED BENZOIC ACID. Pinchas, S. (Weizmann Inst. of Science, Rehovoth, Israel). J. Phys. Chem., 69: 2256-9 (July 1965).

The integrated absorption intensity in the C=O stretching region of a very dilute chloroform solution of a sample of about 50% ^{13}C benzoic acid was measured in comparison with the corresponding intensity of normal benzoic acid. The small decrease observed in this integrated absorption was within the experimental error of the theoretically expected value. The reason for the different effect of ^{13}C and ^{18}O on the C=O band intensity of monomeric benzoic acid is discussed. (auth)

36442 THE INFRARED ABSORPTION OF OXYGEN-18-LABELED PHENOL. Pinchas, S.; Sadeh, D.; Samuel, D. (Weizmann Inst. of Science, Rehovoth, Israel). J. Phys. Chem., 69: 2259-64(July 1965).

The absorption spectra of dilute solutions of normal and 74 at. % ^{18}O phenol were measured in the ranges 4000 to 220-cm^{-1} region. A number of hitherto controversial or doubtful assignments of normal phenol bands were examined critically in the light of the results of these measurements. The origin of a number of bands, belonging to monomeric normal phenol is discussed. It was observed that the integrated absorption intensity of the monomeric phenolic ^{18}O H group stretching band was about 20% lower than that of the corresponding ^{16}O H band although the difference in frequency between them was (in agreement with theory) only about 0.3%. (auth)

36443 THE MOLAR VOLUMES OF LIQUID METHANE AND DEUTEROMETHANE. Fuks, S.; Legros, J.-C.; Bellemans, A. (Universite Libre, Brussels). Physica, 31: 606-12(Apr. 1965).

The molar volumes of liquid CH_4 and CD_4 were measured between 98 and 112°K with a relative accuracy of about 2×10^{-4}. The molar volume of CH_4 is about 1% larger than that of CD_4 over this temperature range. This difference is tentatively interpreted as the result of a translational quantum effect and small differences in the intermolecular forces. (auth)

36444 MÖSSBAUER SPECTROSCOPY OF HEME AND HEMIN COMPOUNDS. Bearden, Alan J.; Moss, Thomas H.; Caughey, Winslow S.; Beaudreau, Charles A. (Univ. of California, San Diego, La Jolla and Johns Hopkins Univ., Baltimore). Proc. Natl. Acad. Sci. U. S.; 53: 1246-53(June 1965)

Mössbauer data for heme compounds agree with the $^6d_\epsilon$, low-spin configuration given by ligand field theory for these nearly octahedral complexes. A high degree of Fe^{2+} ligand π-bonding (covalency) is indicated by the data. The hemin chloride data can be interpreted as indicating a nearly pure high spin ($S = \frac{5}{2}$) state with a temperature-dependent magnetic field at the nucleus broadening the absorption lines. The splittings of the atomic S_z states estimated by Griffith indicate a possible mechanism for the temperature dependence of the magnetic field. This hypothesis could in principle be checked by low-temperature EPR work on hemin chlorides. Also, with a sufficiently high applied field, NMR work could be done on ^{57}Fe nuclei in these compounds. This would show independently the proposed internal magnetic field. (auth)

36445 SPIN DENSITY DISTRIBUTION IN FREE RADICALS. II. O^{17}-HYPERFINE STRUCTURE OF LABELLED O^{17}-2,4,6-TRI-TERT-BUTYL-PHENOXYL. Rieker, Anton; Scheffler, Klaus (Universitaet, Tuebingen, Ger.). Tetrahedron Letters, No. 19, 1337-40(May 1965).

To obtain more information about exact spin density values, 1-^{13}C-2,4,6-tri-tert-butyl-phenoxyl (I) and the ^{17}O-labeled phenoxy radical, namely ^{17}O-2,4,6-tri-tert-butyl-phenoxyl (II), were synthesized and the latter radical characterized. The ir spectrum of III was distinguishable from that of the unlabeled 2,4,6-tri-tert-butyl-phenol through a broadening of the OH-stretching vibration at 3665 cm^{-1} and an additional peak at 770 cm^{-1}. The ESR spectrum of the labeled phenoxy radical is clearly explained as the superimposition of the main spectrum (of the unlabeled compound, I) upon the spectrum of II. The ESR signal of II consists of six components, which are due to the interaction of the free electron with the ^{17}O nucleus (I = 5/2). The coupling constant a_{e-17} equals 10.23 ± 0.1 G. In addition, each of the ^{17}O lines is split into a triplet by the meta protons of the aromatic ring. Due to the non-zero quadrupole moment of the ^{17}O nucleus and the consequent

related relaxation phenomena, the resolution of this additional hyperfine structure in the case of II was worse than in that of I. By comparing the intensity of the ^{17}O HFS lines to the main signal of the unlabeled compound, an enrichment of about 8% in ^{17}O was found in II. From the coupling constant $a_{O-17} = 10.23$ G the proportion of 2s character equal to 1.25% could be calculated. It was, therefore, experimentally proven for the first time that the free electron in phenoxy radicals possesses a definite spin density on the O atom. In other words, an oxygen free radical is present here in accordance with resonance theory. (TCO)

36446 MIGRATION OF METHYL GROUP IN HEPTAMETHYLBENZENONIUM ION: A NEW ROUTE TO PERDEUTEROHEXAMETHYLBENZENE. Koptyug, V. A.; Shubin, V. G.; Korchagine, D. V. (Inst. of Organic Chemistry, U.S.S.R. Academy of Sciences, Novosibirsk). Tetrahedron Letters, No. 21, 1535-7(June 1965).

A new route is described for formation of perdeuterohexamethylbenzene via heptamethylbenzenonium ion, shown previously to be formed as a result of protonation of 4-methylene-1,1,2,3,5,6-hexamethylcyclohexadiene-2,5 (I). A solution of I (605 mg) in 9 ml of deuterotrifluoroacetic acid was held at 70° for 15 min. under a dry nitrogen atmosphere and most of the acid (ca 90%) was removed in vacuo at room temperature. After 6-fold repetition of this procedure, 2 ml of deuterotrifluoroacetic acid and 2 ml of D_2O were added to the residue (1.8 g) and the solution was held at 70° for 48 hr. The solid was separated and dissolved in benzene, and the solution was washed with concentrated HCl and water. The evaporation of benzene yielded 425 mg of solid, mp 165°. Mass spectral analysis showed the total content of D in hexamethylbenzene obtained to be 98 at.%. In the isotopic exchange reaction of H in the ion in the presence of hexamethylbenzene the latter incorporated no deuterium. This confirmed the intramolecular mechanism of migration of the methyl group in the heptamethylbenzonium ion. (TCO)

36447 IONIZATION RATES OF WEAK ACIDS. III. THE ABSENCE OF A PRIMARY KINETIC ISOTOPE EFFECT IN DIMETHYL SULFOXIDE. Hofmann, J. E.; Schriesheim, A.; Nickols, R. E. (Esso Research and Engineering Co., Linden, N. J.). Tetrahedron Letters, No. 22, 1745-7(June 1965).

Discrepancies have been found in the relative rates of base-catalyzed isotopic proton exchange between use of dimethyl sulfoxide as the solvent and comparable data obtained by using cyclohexylamine. To clarify this, work was undertaken on the effect of solvent polarity on relative rates of exchange and the kinetic isotope effect in the dimethyl sulfoxide system. Experiments were carried out by exchanging methyl labeled toluene-d_3 with dimethyl sulfoxide and comparing the observed rate with the corresponding rate for tritium exchange. They were carried out at 30°C using a 0.6M solution of sublimed potassium tert-butoxide in dimethyl sulfoxide. The data show that the value of k_D/k_T in this system is ~1. The possibility of impurity in the deuterated toluene inhibiting the rate of exchange was checked by carrying out tritium exchange in an excess of the deuterated toluene. The data clearly show that the initial ionization of the C–H bond is not the rate determining step when ionization rates are measured in the alkoxide-dimethyl sulfoxide system. It is suggested that it is not ionization but complex stability and concentration that determine exchange. Both factors depend upon the solvating power of the medium and are expected to change depending upon the nature of the base being solvated (i.e., carbon, oxygen, or nitrogen) and the stability of the incipient anion. Such changes are reflected in differences between alkoxide-alcohol-dimethyl sulfoxide solvents and the cyclohexylamine-cyclohexylamide systems. (TCO)

36448 DEUTERATION OF KETONES THROUGH ENAMINES. Schaefer, John P.; Weinberg, David S. (Univ. of Arizona, Tucson). Tetrahedron Letters, No. 23, 1801-4 (June 1965).

Pure 2-deuteriocyclohexanone was prepared in high yield from 1-morpholinocyclohexene using enamine. Deuterolysis of 4-t-butyl-1-morpholinocyclohexene produced 2-β-deuterio-4-t-butylcyclohexanone as would be predicted on stereoelectronic grounds. The orientation of D was determined from a study of the NMR spectrum of the ketone. This method appears to be general and stereospecific for monodeuterating ketones. Consideration of the properties of amines and enamines indicated that the hydrolysis of enamines in weakly acidic solutions might provide a convenient route to ketones in which all of the active hydrogens have been replaced by deuterium. In weakly acidic deuterium oxide, ammonia undergoes almost instantaneous exchange of all its hydrogens for solvent deuterium. Since in the conjugate acid of an enamine all of the β-hydrogens are equivalent and are vinylogous to protons on nitrogen, rapid exchange of these hydrogens might also be expected. Steps using these reactions to prepare polydeuterated ketones are outlined. The technique described can be used to prepare randomly labeled polydeuterated ketone in a matter of minutes from an enamine. Although exchange of all of the active hydrogens should be possible, the optimum conditions for hydrolysis to achieve this result were not found. For the preparation of large quantities of deuterated ketones, utilization of enamines is also particularly economical at the early stages of exchange since more efficient use of deuterium is made than in simple equilibration with deuterium oxide. In addition to forming deuterated ketone on hydrolysis, the N-deuterated amine which is produced can be equilibrated with the ketone. The method was used to synthesize large quantities of 2,2,6,6-tetradeuteriocyclohexanone in high yield using a minimum amount of D_2O. A table shows a comparison of rates of introduction of deuterium into ketones by this enamine route and by simple exchange. (BBB)

36449 NOVEL REACTIONS DURING THE CATALYTIC DEUTERATION OF α-HYDROXY ACIDS AND RELATED COMPOUNDS. Calf, G. E.; Garnett, J. L. (Univ. of New South Wales, Sydney). Tetrahedron Letters, No. 25, 2105-10(July 1965).

Novel reactions were observed during the catalytic labeling of α-hydroxy acids (RR′·C·OH·COOH) and related compounds, such as benzhydrol. Under the described conditions, benzilic acid (R = R′ = C_6H_5) and certain derivatives decompose to di-aryl ketones with the elimination of elements of formic acid, whereas mandelic acid (R = C_6H_5, R′ = H) derivatives are stable and only exchange. 9-Hydroxy fluorene-9-carboxylic acid (I) decomposes to two products, 9-fluorenol and a small amount of 9-fluorenone. With benzhydrol where the –COOH group in benzilic acid is replaced by H, benzophenone is also formed in appreciable yields. In the absence of catalyst the benzilic acids, benzhydrol, and the fluorene derivative (I) are stable. In contrast to the aromatic acids, aliphatic α-hydroxy acids, such as lactic acid, exchange catalytically with D_2O at 120 to 130°C without decomposition. The significant feature of the results is the complete decomposition of I and the relative degree of decomposition exhibited by the various benzilic acids and benzhydrol during exchange in the presence of either hydrogen pre-reduced or self-activated platinum oxide. Because of the observed decomposition, catalytic methods for the labeling of these acids and related compounds should be used with caution since the presence of additional reaction products containing an appreciable concentration of isotope renders purification of the final product difficult, particularly radiochemical purification when tritium is used. Mechanisms whereby the parent α-hydroxy acids and related compounds deuterate or deformylate are discussed. A series of 26 acids related to mandelic and benzilic acids were investigated. (BBB)

Radiation Chemistry

See *also* BIOLOGY AND MEDICINE — Radiation Effects.

Refer also to abstract 37835.

36450 (AD-610557) RADIATION AND OZONE INITIATED GRAFT COPOLYMERIZATION. Report No. 64-3009. McGarvey, J. W. (Rock Island Arsenal Lab., Ill.). Oct. 13, 1964. 18p. CFSTI, $0.50 cy.

Radiation and ozone initiated graft copolymerization reactions were investigated for the synthesis of new technologically useful elastomers. Significant grafting was observed for many of the various combinations of monomers and polymers investigated. Radiation initiated vinylidene chloride-SBR and ozone initiated acrylonitrile-SBR graft copolymers are of particular interest since they exhibit improved oil resistance. (auth)

36451 (BNL-900(p,73-104)) RADIATION DIVISION. Manowitz, B. (Brookhaven National Lab., Upton, N. Y.).

Activities are ranging from fundamental research studies on the interaction of radiation with matter to the design of large-scale irradiators for industrial applications. Radiation research concerned with mechanism studies in radiation-initiated reactions of organic substances is described. Much of the effort is in the area of polymerization where the objective is a greater understanding of the reaction intermediates, their nature (i.e., free radical or ion), and the importance of physical structures in the behavior of these intermediates. Radiation processing research is reported on the use of nuclear energy for industrial chemical processing such as radiolysis of liquid ammonia, the fixation of nitrogen, and engineering-scale exploration of radioinduced processes for ethylene polymerization and copolymerization. Radiation engineering effort is concerned with the problem of engineering processes and process equipment in which radiation is an integral part. Studies are in progress of a gamma monochromator, effects of radiation on fixed and settled beds, design of photoreaction vessels, and alpha source calibrators. The kinetics of the radiation-initiated polymerization of trioxane was studied in the presence and absence of pressure. The free radicals involved in the polymerization of acrylamide were studied over a wide range of temperatures. Rate constants were estimated for the reactions between anthracene in tetrahydrofuran solution and Na. Radiolysis studies of deuterated toluenes lead to the conclusion that ring H atoms are more readily removed than side chain H atoms. Radiation processing effort is concerned with the use of nuclear energy for the synthesis and production of industrial chemicals. The primary effort is divided between a chemonuclear program which uses a nuclear reactor as the source of energy and a radiation chemical processing program which makes use of radioisotopes as the source of energy. Full operation of the High Intensity Radiation Development Laboratory (HIRDL) facility commenced during the period. A 4300-curie ^{137}Cs gamma irradiator for extra-corporeal blood irradiation was constructed and calibrated. Experimental data were used to formulate an empirical relationship which expresses the dose at a target near a single air-water interface as a function of the dose in an infinite medium and the geometry of the point. A calorimeter, for use in source activity and source self-absorption determinations, was constructed. A high-level source assay unit was developed and is currently in use. Specifications were established for an improved metallurgically bonded Co source. (J.R.D.)

36452 (BNL-900(p,105-20)) HOT LABORATORY DIVISION. Stang, L. G. Jr. (Brookhaven National Lab.,, Upton, N. Y.).

An isomer generator was developed in which ^{132}Te was milked in 16% yield from its ^{129m}Te parent. Procedures for removing trace contaminants from milked ^{99m}Tc product solutions were developed. A generator by which 3.9-hr ^{44}Sc can be milked in 75 to 90% yield from its 10^3-yr ^{44}Ti parent was developed. A method of using pressed Cr_2O_3 as a target for the preparation of carrier-free ^{52}Fe was worked out. Procedures for preparing carrier-free ^{132}Cs from the (α,n) reaction on ^{129}TlI were devised. The maximum recoil range of ^{28}Mg from the $^{26}Mg(t,p)$ reaction was found to be 0.88 mg/cm^2 of Mylar. The experimental work to determine the excitation functions for the formation of ^{47}Ca, ^{48}Sc, and ^{49}Sc from alpha bombardment of Ca is virtually complete. The equilibrium constants for the extraction of Am by thenoyltrifluoroacetone (HT) under various conditions were determined, and three species responsible for the synergistic effect of tri-n-octylamine on the solvent extraction of Am by HT were identified. Potentiometric and polarographic studies in the weakly coordinating solvent, dimethyl sulfone, permit investigation of relatively weak metal complexes without the competitive effect of hydration and show, for example, that the half-wave potential of Pb^{+2} and Cd^{+2} differ by <0.02 v in 1M $LiNO_3$. Potential step reversal chronoamperometry was developed to circumvent limitations inherent in more conventional techniques such as current reversal chronopotentiometry and cyclic voltammetry; it is expected to be of particular value in the investigation of fast rate constants. Methods were developed for analyzing for O and C in Na, for detecting ppb levels of Cs and Ta in Hg, and for detecting 0.1 ppm B in blood. Controlled-potential coulometry is being applied to the determination of U in various types of fuel. A variety of standard methods were adapted for specific analyses. Number of shipments of special radioisotopes and average activity per shipment both increased markedly during the year, because of the increased demand for ^{99m}Tc. Improvements were made in generators for ^{99m}Tc, ^{87m}Sr, and ^{132}I. A neutron generator was put into operation during the year, and design was completed on an interim alpha-gamma metallurgy facility. A kilocurie ^{60}Co irradiation facility for studying the kinetics of radiation-induced polymerization was set up. Radioactive liquid waste inventory was reduced to the point where the waste concentrator is being operated only when sufficient waste is accumulated to make a run. (J.R.D.)

36453 (BNL-8836) PROGRESS IN CHEMONUCLEAR AND RADIATION CHEMICAL PROCESS DEVELOPMENT. Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Jan. 1965. Contract AT(30-2)-Gen-16. 47p. Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

The possible forms of chemonuclear and radiation chemical processes are outlined. The factors to be considered in the economics of applying radiation to the production of industrial chemicals are discussed. The relationship between type of chemical reaction and type of chemonuclear reactor (fission-fragment, neutron-gamma, and isotopic-machine) is discussed. The thermal efficiencies of several endothermic reactions being considered for chemonuclear processes, are tabulated, and means for improving the efficiencies are discussed. Exothermic reactions are next considered; experimental work on the chemonuclear fixation of nitrogen and the radiation polymerization of ethylene is described in some detail. (D.L.C.)

36454 (BNL-9104) GAMMA-RADIATION-INDUCED POLYMERIZATION OF ETHYLENE. Kukacka, L. E.; Colombo, P.; Steinberg, M. (Brookhaven National Lab., Upton, N. Y.). Apr. 1965. Contract AT-30-2-GEN-16. 20p. (CONF-650801-1). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From IUPAC Meeting on Macromolecular Chemistry, Prague.

The kinetics and product characteristics of the ^{60}Co gamma-radiation-induced polymerization of ethylene were studied as a function of pressure, radiation intensity, and temperature. Conditions ranged in pressure from 170 to 1360 atm, in temperature from 20 to 200°C, and in radiation intensity from 5.8×10^4 to 8.5×10^5 rads/hr. Activation energies of 0.2 and 14.5 kcal/mole were determined for the temperature ranges 20 to 100°C and 120 to 200°C, respectively. The following empirical relationships for temperatures between 20 and 100°C were developed: $\underline{Q} = 1.39 \pm 0.37 \times 10^{-8}\ \underline{e}^{-200/\underline{RT}}\ \underline{P}^{2.7}\ \underline{I}^{0.5}$, and $\underline{G} = (3.50 \pm 0.95)\ \underline{e}^{-200/\underline{RT}}\ \underline{P}^{2.5}\ \underline{I}^{-0.5}$, where $\underline{Q}$ = polymerization rate, liter-hr; $\underline{G}$ = radiation yield, molecules/100 ev; $\underline{P}$ = pressure, atm; and $\underline{I}$ = radiation intensity, rads/hr. The 0.5 power dependence of the intensity on rate indicates a free radical mechanism. The polymers produced over the entire range of conditions were found to be completely soluble. Densities ranged from 0.95 g/cc for material formed at 20°C to 0.91

g/cc for material formed at 120°C. The weight average molecular weight decreased from 1.5×10^6 to 4.7×10^4 over the same temperature range. The molecular weight was found to increase with pressure and with decreasing radiation intensity. All polymers formed at temperatures below 120°C had a melt index of <0.06 g/10 min. (auth)

36455 (BNWL-SA-199) FREE RADICALS FORMED BY γ IRRADIATION OF ORGANIC SOLUTES IN WATER. Kalkwarf, D. R.; Diebel, R. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 18, 1965. Contract AT(45-1)-1830. 15p. (CONF-650628-1). Dep. (mn); $1.00(cy), 1(mn) CFSTI.

From American Chemical Society, Northwest Regional Meeting, Richland, Wash.

Electron spin resonance (ESR) spectrometry and a flow system including a Gammacell facility, were used to study free radicals within a short time (3 to 5 sec) after their formation in dilute aqueous solutions of organic compounds. For sodium p-nitrobenzoate in deoxygenated water, the ESR spectrum indicates that hydrated electrons react with the anions to form $p\text{-}NO_2C_6H_4CO_2^{\ddagger}$ radicals, while the hydroxyl radical reaction is too slow. Addition of EtOH increases the radical concentration. The decay of signal amplitude was found to be slow and indicated only one radical species but with two decay rates. Similar results were obtained for p-nitroaniline and flavin mononucleotide in deoxygenated water, with hydrated electrons reacting to form long-lived radicals. Aqueous solutions of benzene and sodium benzene sulfonate, however, gave no ESR signal upon irradiation. (D.L.C.)

36456 (NYO-2499-16) ACTION OF MERCAPTAN AND DISULFIDE IN HYDROGEN ATOM EXCHANGE REACTIONS. Cohen, Saul G. (Brandeis Univ., Waltham, Mass. Dept. of Chemistry). May 1, 1965. Contract AT(30-1)-2499. 25p. (CONF-650520-1) Dep.(mn); $1.00(cy), 1(mn) CFSTI

From IAEA Symposium on Exchange Reactions, Upton, N. Y.

Mercaptans and disulfides enter into rapid repetitive H atom transfer reactions which can affect free-radical, photochemical, and radioinduced reactions, leading to change in course and products, to catalysis, or to inhibition. Several examples of such effects in organic reactions are discussed. The inhibition of reduction of benzophenone induced by light and gamma rays is considered in some detail. The mechanisms of the effects are discussed. (D.L.C.)

36457 (NYO-3185-1) COMBINED EFFECTS OF ULTRA-HIGH PRESSURE AND RADIATION ON ORGANIC MONOMERS AND POLYMERS. Final Report, March 1, 1963–October 31, 1964. Prince, Martin (New York Univ., N. Y. Research Div.). Contract AT(30-1)-3185. 92p. Dep. mn; CFSTI, $3.00 cy, $0.75 mn.

The post-irradiative high-pressure polymerization of acrylamide was carried out using gamma rays and electron beams. The irradiated samples were stored at –78°C and subsequently polymerized at pressures up to 500,000 psi. The high pressure gave molecular weight increases up to 100% over non-pressurized systems. Additional reactions with water and alcohols were found to occur under pressure for acrylonitrile and tetracyanoethylene. Condensation reactions of pyromellitic dianhydride with aromatic diamines resulted in intractable solids stable up to ≥250°C. Several sterically hindered ethylene derivatives (tetrachloro-, tetrabromo-, tetraiodo-, and tetracyano-) were studied using the post-irradiation high pressurization technique; only tetrabromoethylene and tetracyanoethylene were made to react. The development of an ultra-high pressure ^{90}Sr capsule for irradiations at high pressure is described. (D.L.C.)

36458 (NYO-3334-1) RESEARCH ON APPLICATIONS OF RADIATION-INDUCED REACTIONS IN GASES. Final Report. Feibush, Arthur M. (Air Reduction Co., Inc., Murray Hill, N. J. Research and Engineering Dept.). Feb. 12, 1965. Contract AT(30-1)-3334. 56p. Dep. mn; CFSTI, $3.00 cy, $0.75 mn.

Two processes were developed for the laboratory scale production of wood–poly[vinyl chloride] composites by irradiation of wood impregnated with liquid vinyl chloride. In one method, the impregnation and irradiation are performed at room temperature under pressure. In the other, the entire process is completed at –78°C and does not require the use of pressure vessels. Coloring agents may be introduced in either process to produce colored products. The radiation-processed wood–poly[vinyl chloride] composites showed improved properties in comparison with untreated wood. Measurements of dimensional stability, compressive strength, flexural strength, hardness, abrasion resistance, chemical resistance, and fire resistance were made. The use of radiation processing for the formation of wood–polyethylene composites was also demonstrated, but the method was not successful for producing wood–polypropylene composites. Radiation-induced polymerization-addition reactions were shown to occur in mixtures of unsaturated hydrocarbons with sulfur dioxide, ammonia, oxygen, and ammonia and oxygen. (auth)

36459 (RAI-3333-1) UPGRADING OF BY-PRODUCT POLYPROPYLENE BY RADIATION TECHNIQUES. Final Summary Report, February 1, 1964–January 31, 1965. Bernstein, Bruce S.; Lee, Joseph; Orban, Gyula (Radiation Applications Inc., Long Island City, N. Y.). Mar. 15, 1965. Contract AT(30-1)-3333. 65p. Dep. mn; CFSTI, $3.00 cy, $0.75 mn.

By-product polypropylene, obtained as a waste product during the preparation of stereoblock homopolymer, was upgraded so that its tensile strength was increased as much as fifteen-fold over the original polymer. Upgrading techniques involve the blending of silica reinforcing agents and polyfunctional monomers into the polypropylene followed by low dose radiation. Prior modification of the silica reinforcing agents by treatment with vinyl trichlorosilane to impart a double bond onto the filler, further aids the ultimate properties. The vinyl silicas are incorporated into the crosslinked structure by primary covalent bonds after radiation processing. The degree of improvement is dependent upon residual crystallinity level (i.e., polymer nature), radiation dose, polyfunctional monomer concentration, and reinforcing nature and level. Thus, a by-product polypropylene containing 33% crystallinity modified with 25% vinyl silica and allyl methacrylate monomer (present at a molar monomer/polymer ratio of ca. 150/1) possesses a tensile strength of greater than 1200 psi after only 3.3 Mrads. Increasing the radiation dose or molar monomer/polymer ratio can lead to even further increases in tensile strength properties. The degree of residual crystallinity in the by-product grade is a significant factor in the radiation upgrading process; high total crystallinity is desirable. Molecular weight is not as important a factor when polyfunctional monomer is present to aid radiation crosslinking. (auth)

36460 (TID-21016) PHOTOCHEMISTRY OF 1,3-DIMETHYLTHYMINE IN AQUEOUS SOLUTION. Alcantara, Raul; Wang, Shih Yi (Johns Hopkins Univ., Baltimore, Md. School of Hygiene and Public Health). [1963]. Contract AT(30-1)-2798. 18p. Dep. (mn); CFSTI, $1.00(cy), 1(mn).

Seven products were identified in the u-v irradiation of an aqueous solution of 1,3-dimethylthymine under conditions that resulted in a 50% decrease in the original u-v absorbancy. These products were: methylamine, ammonia, 5-carboxy-1, 3-dimethyluracil, acetic acid, formic acid, two unidentified acids, and 5-formyl-1,3-dimethyluracil. Experiments were conducted to study the mechanism for the formation of 5-carboxy-1,3-dimethyluracil. (D.L.C.)

36461 (TID-21017) PHOTOCHEMISTRY OF THYMINE IN AQUEOUS SOLUTION. Alcantara, Raul; Wang, Shih Yi (Johns Hopkins Univ., Baltimore, Md. School of Hygiene and Public Health). [1963]. Contract AT (30-1)-1822. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI

The photo-oxidation of the 5-methyl group of 1,3-dimethylthymine was clearly demonstrated by the identification of 5-formyl-1,3-dimethyluracil and 5-carboxy-1,3-dimethyluracil among the products. Since this reaction could be of significance in biological systems, a similar study was carried out using the DNA base component,

thymine, to observe whether or not the same oxidation occurred. An aqueous solution of thymine was irradiated with ultraviolet light and the photoproducts from this irradiation were separated via paper chromatography. The preliminary results from these experiments indicated uracil, 5-HMU, 5-FMU, and 5-CBU are photoproducts of thymine. For comparison purposes, 5-formyluracil, 5-carboxyuracil, and 5-hydroxymethyluracil were prepared. An improved procedure used for the synthesis of 5-formyluracil is reported. (C.H.)

36462 (TID-21090) RADIOLYSIS OF 1,5,9-CYCLODODECATRIENE. Wiley, Richard H.; Lipscomb, N. T.; Rivera, W. H. (Louisville Univ., Ky. Dept. of Chemistry). [1961]. Contract AT(40-1)-2055. 7p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

Cobalt-60 γ-irradiation-induced decomposition of liquid cis-trans-trans 1,5,9-cyclododecatriene at 2×10^5 rad/hr. and total doses of 4.75 to 157.5×10^6 rad gives hydrogen (G = 0.437), acetylene (G = 0.006), ethylene (G = 0.005), and propane/propene (G = 0.0004). The $G(H_2)$ values are intermediate between those for cyclohexene (G = 1.2), benzene (G = 0.04), and cyclooctatetraene (G = 0.02) and the yield of cleavage products is of the same magnitude as for benzene and cyclooctatetraene. These low values indicate a stability attributable to cage effects. (auth)

36463 (TID-22060) STUDIES IN SOLUTION AND NUCLEAR CHEMISTRY. Progress Report for Period October 1, 1964–September 30, 1965. Marinsky, Jacob A.; Clarke, George A. (State Univ. of New York, Buffalo. Dept. of Chemistry). July 1, 1965. Contract AT(30-1)-2269. 143p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

A report is given of research that has been and is being conducted (1) to elucidate the ion-exchange phenomenon and (2) to study the solution chemistry of the alkali metals, the alkaline earths, the transition elements, and the rare earths. Various ion-forms of polystyrene sulfonate, the polyelectrolyte analogue of the commercially produced ion-exchange resins (Dowex-50 and IR-120), are being employed to facilitate the first objective. Ion-exchange as well as polarographic and potentiometric techniques continue to be employed to accomplish the second objective. A study of heavy atom effects on the energy transfer processes in analogues of well-characterized rare earth chelates was initiated. The heterocyclic β-diketone ligands were prepared and characterized by NMR and absorption spectroscopy and solvent effects on the relevant absorption bonds were investigated. Preliminary work on the absorption and emission of the tetrakis diketonates is reported. Plans are proposed for the expansion of the program to the ensuing year. (J.R.D.)

36464 LABORATORY-SCALE β IRRADIATION DEVICE. Cserep, Gyoergy; Foeldiak, Gabor; Stenger, Vilmos (National Atomic Energy Commission, Budapest). Atomtech. Tajekoztato, 8: 150-8(1965). (In Hungarian)

A sealed $^{90}Sr-^{90}Y$ source was selected to carry out studies on the chemical radiation effects of high-activity β emitters. The source possesses an energy of 0.54 and 2.26 Mev and a half life of 28 years. The dose rate of the source was equivalent to that of a 40- to 50-C ^{60}Co source. The active material is embedded in glass and covered with Al foil for radiation protection. Pb bricks are also provided to absorb the generated bremsstrahlung. A Plexiglas cover makes it possible to make direct observations. The dose rate of the source was determined by means of a Fricke dosimeter. Dynamic measurements on continuously flowing fluids were carried out with the device. It could be advantageously used to study radiation effects on P, semiconductors, and plastic sheets, and to examine biological processes. The design allows it to be installed in an ordinary chemical laboratory. (TTT)

36465 ON THE HIGH-DOSE X-RAY INDUCED ELECTRIC CONDUCTIVITY IN POLYETHYLENE. Wojtech, Leonard (Max Planck-Institut fuer Biophysik, Frankfurt). Biophysik, 2: 217-25(1965). (In German)

The x-ray induced conductivity of the polyethylene plastic Trespalen was studied at high dose rates between 2.4×10^3 and 1.1×10^5 Rads/min by means of a high output x-ray machine constructed. The induced conductivity σ and the dose rate L showed the dependance $\sigma \propto L^{0.8440.03}$. During irradiation at the level of 1.1×10^5 rads/min the conductivity was increased from 7×10^{-20} (ohm cm)$^{-1}$ to 9×10^{-15} (ohm cm)$^{-1}$. The decay of the induced conductivity was approximated by a superposition of two hyperbolas with the time constants 0.018 and 5.3 minutes. When the induced current had decayed no increase of normal conductivity occurred up to accumulated doses of 20 MR. (auth)

36466 THE EFFECT OF NITROUS OXIDE ON THE γ-RADIOLYSIS OF LIQUID METHANOL. Seki, Hiroshi; Imamura, Masashi (Inst. of Physical and Chemical Research, Tokyo). Bull. Chem. Soc. Japan, 38: 1229(July 1965).

Extra-purl methanol was rectified after it was refluxed with sodium borohydride. The middle third of the distillate was dried over magnesium turnings by refluxing. Pure nitrous oxide was further purified by distillation. The solutions were irradiated with ^{60}Co γ rays at a dose rate of $(1.4 \text{ to } 1.5) \times 10^{17}$ ev/ml/min for about 150 min. The products were determined. The addition of nitrous oxide decreased the $G(H_2)$ and led to the formation of nitrogen in spite of the effect of nitrous oxide on $G(H_2)$, the yields of all the other products remain unaffected, and the limiting $G(H_2) + G(N_2)$ value was 5.4, which was the same as the $G(H_2)$ values for pure methanol. The nitrous oxide was assumed to react solely with the solvated electrons in the irradiated methanol, the yield of the solvated electron should be equal to the limiting $G(N_2) = 2.1$. (F.J.H.)

36467 ELECTRON IRRADIATION ON HYDROCARBONS. III. RADICAL REACTIONS AND DIFFUSION DURING RADIOLYSIS. Claes, P.; Rzad, S. (Univ. of Louvain, Belg.). Bull. Soc. Chim. Belges, 74: 220-31(May-June 1965).

A theoretical study was made of the influence of track expansion on radical reactions occurring during the radiolysis of hydrocarbons. It was shown that a dose-rate effect on the organic products yields may occur. This should be due to the competition between radical recombination and hydrogen abstraction from the solvent by these radicals. Hydrogen atoms, however, react chiefly by hydrogen abstraction from the solvent. (auth)

36468 INFRARED SPECTROSCOPIC STUDIES OF GRAFTED CELLULOSE. DasGupta, Sharda (Atomic Energy of Canada Ltd., Ottawa). Can. J. Spectry., 6p. (Jan. 1965). (AECL-2087)

New techniques were developed for grafting monomers such as styrene and methyl methacrylate onto cotton fabrics and paper under the influence of gamma radiation. The products have vastly improved properties. The mechanisms of the grafting reaction, the probable active sites and the quality of the products were studied at various stages by infrared spectroscopic techniques. Such studies have made it possible to follow the reactions and thus obtain desired properties. Spectra of the deuterated grafted products revealed that grafting takes place at the free and intermolecular hydrogen bonded regions. A possible reaction mechanism indicating the role of short lived and long lived free radicals is discussed. A structure of the grafted network is proposed. (auth)

36469 DIRECT CONVERSION OF NUCLEAR ENERGY INTO CHEMICAL ENERGY. Schindewolf, U. (Technische Hochschule, Karlsruhe, Ger.). Chem.-Ingr.-Tech., 36: 15-23(Jan. 1964). (In German).

By radiochemical processes endothermic chemical reactions can be caused, in which the radiation energy is partly transformed to chemical energy. Only reactors are considered as the radiation source. Principles of chemonuclear processes are considered. The technological possibilities and the scientific outlook for the preparation of glycol from methanol and of nitric oxide from air are discussed. Possible construction of a chemical-

nuclear reactor is described and economic aspects are considered. (M.C.G.)

36470 LOCALIZATION OF ENERGY IN RADIOLYSIS OF SOLUTIONS. III. Notes to the Paper: ENERGY PARTITION IN THE RADIOLYSIS OF AROMATIC MIXTURES BY C. E. KLOTS AND R. H. JOHNSEN. Bednar, J. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez.). Collection Czech. Chem. Commun., 30: 1427-32 (May 1965).

Results of the radiolysis of mixtures of benzene with pyridine are in agreement with the assumption on the role of the electron excitation spectra in the radiolysis of mixtures. The linear dependence of the yield on the electron fraction of the components is a special case ensuing from the isoelectronicity and the very similar electronic spectra of both compounds. (auth)

36471 RADIATION CHEMISTRY. Danno, Akibumi (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 11: No. 4, 37-44(Apr. 1965). (In Japanese)

One of the three principal aims of the peaceful uses of atomic energy is the use of radiation energy from various sources to trigger chemical reactions. Advances during the past ten years are described. The greatest field for radiation utilization is considered to lie in polymer chemistry in which radiation is used to catalyze polymeric reactions and crosslinking. A great deal of effort is being expended on graft polymerizations which can take place by radical, ionic, or solid-state paths. Advances in radiation chemistry are cited, including discussions of ion-molecule reactions, short-lived radicals, and the hydrated electron. The radioinduced production of ethyl bromide patented by the Dow Company is given as an example of the potential of reactions induced by radiation in industrial fields. (TTT)

36472 ELECTRON SPIN RESONANCE SPECTRUM OF GAMMA IRRADIATED ANHYDROUS POTASSIUM THIOSULPHATE. Mahadevappa, D. S.; Eager, R. L. (Univ. of Saskatchewan, Saskatoon, Can.). Indian J. Chem., 3: 222-3(May 1965).

The electron spin resonance spectrum of gamma-irradiated anhydrous potassium thiosulphate was studied. The doublet-like structure was interpreted as the resultant of the superposition of spectra of two radicals centred at g = 2.004 and g = 2.006. The formation of SO_2^- radical ions in the irradiated crystal was speculated. (auth)

36473 HYDRAZINE FORMATION IN THE FISSION-FRAGMENT RADIOLYSIS OF LIQUID AMMONIA. White, E. R. (IIT Research Inst., Chicago). Intern. J. Appl. Radiation Isotopes, 16: 419-24(July 1965).

The dependence of the yield of hydrazine on total dose in the fission-fragment irradiation of liquid ammonia was investigated. Experiments were carried out in a nuclear reactor in which the fission fragments were produced by the bombardment of ^{235}U with thermal neutrons. The most significant result of the investigation was the fact that large G-values could be obtained for hydrazine, but only at relatively small total doses of energy. A value of 1.5 mol. of hydrazine/100 ev was obtained at the lowest dose studied, but $G(N_2H_4)$ decreased rapidly with increasing dose and approached a value of approximately 0.1. This result was in agreement with the accepted mechanisms, which were postulated to explain the destruction of hydrazine. (auth)

36474 SPECTRAL AND SCINTILLATION PROPERTIES OF SOME METHYL AND VINYL DERIVATIVES OF p-POLYPHENYLS. Sandler, S. R. (Borden Chemical Co., Philadelphia). Intern. J. Appl. Radiation Isotopes, 16: 425-9(July 1965).

Spectral and scintillation properties of some methyl and vinyl derivatives of biphenyl p-terphenyl and p-quaterphenyl are presented. The methyl derivatives appeared to increase the scintillation efficiency and solubility in organic solvents. Some practical applications are recommended. (auth)

36475 ISOTOPE EFFECTS IN THE RADIATION CHEMISTRY OF WATER. Lifshitz, Chava; Stein, G. (Hebrew Univ., Jerusalem). Israel J. Chem., 2: 337-53(Feb, 1965).

Isotope effects in irradiated water vapor, liquid water, and ice are discussed in terms of primary reactions leading to hydrogen atoms and hydrogen molecules, in order to correlate events taking place in the three phases. The points of interest in the liquid are shown to be the origin of the "residual yield" in neutral solutions and the various processes leading to molecular hydrogen. The experimentally observed isotope effect for the residual yield clearly outruled the formation of a hydrogen atom from a single excited water molecule. The dependence of the isotope effect for the molecular yield on the concentration of electron scavengers showed that more than one process gives hydrogen molecules. Of particular interest, for comparison with the liquid, would be determinations of isotope effects in the gas phase and in ice at 77°K, as well as the determination of the isotope effect for the recombination reaction of two aquated electrons. (auth)

36476 POLYMERIZATION IN THE CRYSTALLINE STATE. VII. A CRYSTALLOGRAPHIC STUDY OF THE RADIATION-INITIATED POLYMERIZATION IN SINGLE CRYSTALS OF VINYL STEARATE. Morosoff, N.; Morawetz, H.; Post, B. (Polytechnic Inst. of Brooklyn). J. Am. Chem. Soc., 87: 3035-40(July 20, 1965).

The crystal structure of vinyl stearate was determined and the nature of the radioinduced solid-state polymerization of this monomer was studied by following changes in the x-ray diffraction patterns of single polymerized crystals. The monomer has a layer structure with vinyl groups lying in sheets separated by 25.4 Å. The chain propagation seemed to proceed within these layers, and the parallel orientation of the stearate residues was preserved during this process. During polymerization, the side chains rotated around the b axis of the monoclinic crystal of the monomer and assumed orientations almost perpendicular to the plane containing the monomer end groups; the packing of the side chains attained hexagonal symmetry in a manner similar to that characterizing allotropic phase transitions of paraffins in the neighborhood of their melting point. A discrete monomer phase was observed in crystals containing as much as 30% polymer but disappeared at a 40% polymer content. Infrared spectral analysis indicated that poly(vinyl stearate) produced in the solid state was more isotactic than polymer prepared in a liquid phase. The manner in which the oriented side chains were attached to the chain backbone and the significance of low angle reflections observed with the polymer present problems not yet resolved. (auth)

36477 RADIATION-INDUCED AMMONOLYSIS OF CARBON TETRACHLORIDE. Davis, Douglas D.; Hanrahan, Robert J. (Univ. of Florida, Gainesville). J. Am. Chem. Soc., 87: 3088-92(July 20, 1965).

The major products formed in the γ radiolysis of carbon tetrachloride and ammonia solutions were ammonium chloride, ammonium dicyanamide, and hexachloroethane. Minor products included cyanoguanidine, guanidine hydrochloride, and nitrogen. The G values of these products were as follows: ammonium chloride, 25.3; ammonium dicyanamide, 2.36; hexachloroethane, 2.13; cyanoguanidine, 0.48; guanidine hydrochloride, 0.53; and nitrogen, 0.80. A reaction scheme is given, which explains the formation of these products on the basis of a common precursor, cyanogen chloride. Such a precursor seems to account for both the large yield of ammonium chloride and the great abundance of nitrile groups found in stable products. A comparison with the thermally induced reactions studied earlier by Watt and Hahn revealed that in both cases the same reaction scheme appeared to be applicable. (auth)

36478 PHYSICAL PROPERTIES AND STRUCTURE OF THE POLYETHYLENE PRODUCED BY γ-RADIATION POLYMERIZATION. Machi, Sueo; Tamura, Takeshi; Fujioka, Shuji; Hagiwara, Miyuki; Gotoda, Masao; Kagiya, Tsutomu (Japan Atomic Energy Research Inst., Tokyo and Takasaki Radiation Chemistry Research Establishment, Japan). J. Appl. Polymer Sci., 9: 2537-47(July 1965).

Polyethylene produced by γ radiation had short-chain

branching to some extent and a small amount of vinylidene unsaturation. An OH group was found in polyethylene produced in the presence of methanol. The properties and structure of the polymer were found to vary widely with changes in the reaction condition, such as ethylene pressure, reaction temperature, time, and dose rate. Polymer density, an important property, varied from 0.88 to 0.96 g/cc and crystallinity varied from 40 to 80%, depending on the reaction conditions. Polyethylene polymerized at room temperature at a pressure of 300 to 400 kg/cm^2 was shown to have an extremely high molecular weight (up to 300,000) and low methyl content (below 0.5CH_3/100C). Density depended solely on the crystallinity of the polymer, which was found to be determined by the degree of short-chain branching and molecular weight. Quantitative relationships between them were obtained. The use of methanol as a solvent was found to have no effect on short-chain branching but to have a marked effect on molecular weight; hence, high-density polyethylene could be obtained with the use of methanol solvent. Polyethylenes with a high molecular weight (above 100,000) had a higher melting point than high-pressure polyethylene. The quantitative correlation between molecular weight and melt index was also determined and found to be similar to that of Sperati. Some mechanical properties were also measured. (auth)

36479 EFFECT OF γ RADIATION ON THE PARTIAL OXIDATION OF HYDROGEN. Nield, L. A.; Albright, L. F. (Purdue Univ., Lafayette, Ind.). J. Chem. Eng. Data, 10: 275-8(July 1965).

The effect of gamma radiation on the partial oxidation of hydrogen was investigated in a stainless steel, tubular flow reactor. Runs were made in and out of a cobalt-60 source, which provided a radiation intensity of about 110,000 roentgens per hour. The variables of temperature (330 to 400°C), hydrogen-to-oxygen mole ratio (1 to 8), residence time (2 to 16 seconds), and pressure (up to 12 atm.) were investigated. The optimum increase in oxygen conversion caused by γ radiation was about 50% and was obtained for a hydrogen-to-oxygen ratio of 4:1, at a residence time of 2 seconds, a pressure of 1 atm, and at a temperature of about 400°C. Oxygen conversion was greatest for irradiated runs and increased with increasing hydrogen-to-oxygen mole ratio, increasing residence time, and increasing temperature. The oxygen conversion decreased with increasing pressure. However, the rate of reaction increased with pressure at a relatively low order. (auth)

36480 PULSE RADIOLYSIS STUDIES. VIII. KINETICS OF FORMATION OF TRIPLET STATES OF AROMATIC MOLECULES IN ACETONE SOLUTIONS. Arai, Shigeyoshi; Dorfman, Leon M. (Argonne National Lab., Ill.). J. Phys. Chem., 69: 2239-44(July 1965).

The pulse radiolysis method was used to identify aromatic triplet states in electron-irradiated solutions. The triplet states of naphthalene, anthracene, and 1,2-benzanthracene were identified from the optical absorption spectra in acetone solutions of these arenes. The energy transfer process between the solvent and solute molecules was studied by direct observation of the kinetics of formation of the triplet state. The absolute bimolecular rate constants for triplet formation were found to be: $(6.2 \pm 0.6) \times 10^9 \underline{M}^{-1}$ sec^{-1} for anthracene and $(4.5 \pm 0.9) \times 10^9 \underline{M}^{-1}$ sec^{-1} for naphthalene, both at 23°C in acetone. The data indicated a half life greater than 5 μsec (for a first-order decay) for the precursor in pure acetone. The G value for all three of the triplets observed was found to be between 1 and 2 molecules/100 ev. The mononegative molecule ion of anthracene was also identified from its absorption spectrum and was found to have a G value of 1.7 ± 0.6 molecules/100 ev. (auth)

36481 RADIATION-INDUCED REACTIONS IN n-HEXADECANE. Salovey, R.; Falconer, W. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Phys. Chem., 69: 2345-56(July 1965).

The effects of irradiation of n-hexadecane were apparently independent of source and dose rate, the major effect being C–H rupture resulting in dimerization by cross linking to form isomers of dotriacontane and hydrogen. Chromatographic analyses of products indicated that scission of the paraffin chain was suppressed in the irradiation of solid n-hexadecane relative to irradiation in the liquid state. Mass spectrometric studies of gases evolved following irradiation and molecular weight measurements by vapor pressure depression were consistent with this observation. Increased chain scission in irradiated polyethylene melts may explain the reduction in gel measured under such conditions. From the distribution of isomeric dimers on irradiation of pure n-hexadecane it was concluded that the main sites of cross linking are nonterminal. That is, cross linking occurs at random and there is no need to postulate radical-center mobility. However, irradiated solid n-hexadecane containing 5% n-octadecane end links to form linear dotriacontane to the extent of about 2% of total dimer. (auth)

36482 ISOTOPIC EXCHANGE IN NITROGEN GAS INDUCED BY γ-RADIATION. Dawes, D. H.; Back, R. A. (National Research Council Labs., Ottawa). J. Phys. Chem., 69: 2385-92(July 1965).

Isotopic exchange in nitrogen gas induced by γ rays was studied at pressures from 100 to 400 torr, at dose rates of about 10^5 and 10^6 r/hr and at ambient temperatures. A value of $G_{exchange} = 7.3 \pm 0.5$ molecules/100 ev was found, independent of pressure, dose rate, and conversion. The effects of O_2, NO, N_2O, C_3H_6, Ne, Xe, and an electric field were also examined. A mechanism for the exchange was postulated, which involved the random combination of nitrogen atoms formed by neutralization of ions and by dissociative excitation, together with a nonatomic process. It was suggested that the latter may be the exchange of atoms in the N_4^+ ion. (auth)

36483 γ-RADIOLYSIS OF AMMONIUM PERCHLORATE. Odian, George; Acker, Terese; Pletzke, Thomas (Columbia Univ., New York). J. Phys. Chem., 69: 2477-9 (July 1965).

Ammonium perchlorate was recrystallized twice from deionized water, dried, and then irradiated in stoppered test tubes with ^{60}Co gamma rays at 10 to 15°C at a dose rate of 0.36 Mrad/hr. No precautions were taken to exclude air from the specimens prior to radiolysis. The irradiated ammonium perchlorate was dissolved in water and analyses were performed for chlorate, chlorine, dioxide, chlorite, hypochlorite, chlorine, chloride, and the total of nitrite plus nitrate. In the analyses chlorine dioxide and chlorite were found not to be products of ammonium perchlorate radiolysis in any appreciable amount. The source was observed for nitrate plus nitrite. Chlorate, hypochlorite, chlorine, and chloride were found to be the major products of the radiolysis of ammonium perchlorate. (F.J.H.)

36484 KINETICS OF THE γ-RADIATION-INDUCED LOW TEMPERATURE POLYMERIZATION OF METHYL METHACRYLATE. Lipscomb, N. Thornton; Weber, Edwin C. (Univ. of Louisville, Ky.). J. Polymer Sci., Pt. A, 3: 55-61(Jan. 1965).

Studies were made on the rates of γ radioinduced polymerization of methyl methacrylate in bulk between the temperatures of −19 and −49°C and at radiation intensities from 3.77×10^5 to 1.35×10^5 rad/hr. The activation energy over this temperature range was found to be 3.85 kacl/mole at 3.77×10^5 Rad/hr. The rate of the reaction was found to be proportional to the intensity to the 0.33 power at both −19°C. and −49°C. Molecular weight information showed that transfer to monomer was unimportant in the polymerization. Nuclear magnetic resonance studies showed that the amount of syndiotacticity in the polymer increases with decreasing temperature. (auth)

36485 ELECTRON SPIN RESONANCE SPECTRA OF POLY(METHYL METHACRYLATE) IRRADIATED AT 77°K. Hajimoto, Yoshioki (Matsushita Research Institute Tokyo, Inc., Ikuta, Kawasaki-shi, Kanagawa, Japan); Tamura, Naoyuki; Okamoto, Shigeharu. J. Polymer Sci., Pt. A, 3: 255-63(Jan. 1965).

It is shown that there exists a difference in the electron spin resonance spectrum of poly(methyl methacrylate) irradiated with electrons and observed at 77°K and at room temperature. One of the radicals trapped at 77°K is probably $\cdot COOCH_3$, which gives the spectrum of a single line, and the others giving triplet and quartet are perhaps $\cdot CHO$ and $\cdot CH_3$, the splitting of which are 132 and 23 gauss, respectively. With the elevation of the annealing temperature the unstable radicals recombine or convert to the stable radicals; near room temperature they are completely replaced by the stable radical which gives the nine-line spectrum. (auth)

36486 RADIATION POLYMERIZATION OF CRYSTALLINE TRITHIANE. Lando, J. B.; Stannett, V. (Research Triangle Inst., Durham, N. C.). J. Polymer Sci. Pt. A, 3: 2369-82(June 1965).

The polymerization of single crystals and finely powdered samples of trithiane (mp 215-216°C) was accomplished by irradiation of the samples at room temperature with ^{60}Co γ radiation to doses of 1-10 MRad. Polymerization occurred during subsequent heating of the samples 180°C. The conversion to polythiomethylene after a given time of heating at 180°C is dependent on radiation dose, the G values for conversion being higher at lower doses. Purified polymer samples were studied by means of differential thermal analysis. Polymerized single crystals of trithiane were found to retain their orientation in three dimensions, although the polymer samples were systematically twinned. The directions of greatest chain growth were along the diagonals in the (ab) plane of the monomer. This reaction can be classified as topotactic; that is, the molecular orientations of the product are correlated with the molecular orientation in the reactant crystal. The relationship between the polymer structure and that of the monomer is evaluated. (auth)

36487 POLYMER PRODUCTION FROM AQUEOUS SOLUTIONS OF d-GLUCOSE BY HIGH-ENERGY RADIATION. Snell, John B. (Inst. of Paper Chemistry, Appleton, Wisc.). J. Polymer Sci., Pt. A, 3: 2591-2607(July 1965).

Polymeric material was produced by passing aqueous glucose solutions under a beam of high-energy electrons. The yield of polymer increased with dose and dose rate. The weight-average molecular weights of polymers formed at 40 Mrad, measured by light scattering, ranged from 9,800 to 5,000,000. The polymers exhibited very low intrinsic viscosities in water, and were therefore thought to be highly branched. Measurement of the number-average molecular weight of one of the polymers by osmometry established an $\bar{M}_w/\bar{M}_n$ ratio of 4.9, indicating a fairly broad distribution of molecular weights within the polymer. One polymer was fractionated on Sephadex and the chemical composition of the fractions compared. The carboxyl content increased regularly with molecular weight, suggesting that the carboxyl groups were the result of secondary oxidative attack. Hydrogen and oxygen contents decreased with increasing molecular weight. Elemental analysis and infrared spectral data on the fractions were consistent with the hypothesis that gluconolactone was incorporated into the polymer in the early stages of formation. Chromophoric groups, perhaps of the endiol type, were formed, and oxygen-rich fragments were apparently lost as the molecular weight of the polymer increased. Oxygen contents, on the other hand, decreased with increasing molecular weight. The regularity observed in the fraction analyses suggested that the polymerization followed a pattern, and was not the result of the random joining of unlike fragments. (auth)

36488 ELECTRON IRRADIATION AND RACEMIZATION OF ISOTACTIC POLY(METHYL METHACRYLATE). Thompson, Edward V. (American Cyanamid Co., Stamford, Conn.). J. Polymer Sci. Pt. B, 3: 675-8(Aug. 1965).

Electron irradiation of poly(methyl methacrylate) resulted in partial racemization of the polymers. Samples of isotactic poly(methyl methacrylate) were subjected to irradiation using 3.0-Mev electrons. To prevent overheating, the irradiation was done in stages of 1.5 Mrad. The total dose and certain physical properties of the resulting polymers are given in a table. (F.J.H.)

36489 RADIATION-INDUCED COPOLYMERIZATION OF α-METHYLSTYRENE WITH MALEIC ANHYDRIDE. Shu, So-Sei; Tabata, Yoneho; Oshima, Keichi (Tokyo Univ.). Kogyo Kagaku Zasshi, 67: 2159-63(Dec. 1964). (In Japanese)

Irradiation with ^{60}Co, at dose rates of 4.7×10^3 to 1.05×10^5 R/hr, was employed to investigate the radioinduced copolymerization of α-methylstyrene with maleic anhydride, both in bulk and in solution, with chloroform. Irradiations were carried out at temperatures between –20 and 47°C. Thus, effects of temperature and dose rate, as well as molar concentration of one component in the monomer mixture and radical scavengers on the copolymerization, were investigated. The IR spectra and the melting point of the copolymers obtained were measured; elementary analysis of the copolymers was also carried out. As found earlier with styrene, the copolymerizations were not preceeded by an induction period. Copolymerization was completely inhibited by 2,2′-diphenylpicrylhydrazyl (DPPH) and pyrogalol when added at levels of 2%. Apparent activation energies of 6.7 and 5.4 kcal/mole were obtained for bulk copolymerization (3.6 mole% of maleic anhydride for α-methylstyrene) and for solution copolymerization (8 wt % chloroform solution of an equimolar mixture of both monomers), respectively. It was concluded from both IR and elementary analyses of the copolymer that a homopolymerization of each monomer did not take place under the experimental conditions used and that alternating copolymerization possibly took place over a wide range of monomer concentration of one component. The radicals involved and a possible reaction mechanism are outlined. (BBB)

36490 IRRADIATION CHANGES IN ORGANIC AND INORGANIC OBJECTS. Reimer, L. (Universitaet Munster, Ger.). Lab. Invest., 14: 1082-96(June 1965).

At a magnification of about 10,000 diameters with current densities of about 10^{-2} amp/cm^2, the object absorbs (at 60 kev) a dose of $\approx 6 \times 10^9$ rads/sec. The mechanism of radiation damage was studied. Ways of measuring the loss of substance caused by electron irradiation were evaluated. In organic materials there was found to be a correlation between the chemical composition, carbon content, and remaining mass of the object. Loss of crystallinity was also measured. Crystals of small aliphatic molecules such as glycogen deteriorated at very small doses. The necessary dose increased with increasing length of the molecules. All aliphatic compounds, however, required lower doses that aromatic compounds. Changes in optical absorption properties and in electrical properties of organic objects were also determined. Irradiation changes of inorganic objects were also studied. (M.C.G.)

36491 IRRADIATION CHANGES IN ORGANIC POLYMERS AT VARIOUS ACCELERATING VOLTAGES. Kobayashi, K.; Sakaoku, K. (Kyoto Univ.). Lab. Invest., 14: 1097-1114(June 1965).

The effects of electron irradiation on organic specimens in electron microscopy were studied and the rates of damage at various accelerating voltages up to 300 kv were compared. Single crystals of organic polymers (polyethylene, polyoxymethylene, polyethylene oxide, and nylon 6) were chosen as specimens. The main reaction induced by ionization of the carbon atoms was crosslinking between adjacent molecular chains. It was concluded that the cross section for inelastic scattering decreases with increasing acceleration voltages. The higher the acceleration voltage, the less the damage of the specimen for a given dose of irradiation. (M.C.G.)

36492 THE ELEMENTARY COMPOSITION OF ORGANIC OBJECTS AFTER ELECTRON IRRADIATION. Bahr, G. F.; Johnson, F. B.; Zeitler, E. (Armed Forces Inst. of Pathology and Veterans Administration Central Lab. for Anatomic Pathology and Research, Washington, D. C.). Lab. Invest., 14: 1115-33(June 1965).

The elementary composition of electron-irradiated organic objects was studied, Data are presented on polyethylene, polyester, tetrafluoroethylene polymer, fluorinated ethylene propylene polymer, polyvinylchloride, polyvinyl formed, polyvinylpyrrolidone iodine, polyamide, and gelatin. Radioinduced changes in organic objects at conventional accelerating voltages of electron microscopy proceeded very fast initially, leveling off at relatively low doses. The logarithms of the losses of mass and elements were approximately a linear function of dose, suggesting first-order reactions. Sensitivity to irradiation with 75-kv electrons was inversely proportional to the bond energy. The halogens, especially fluorine, were particularly sensitive to radiation. (M.C.G.)

36493 CONTAMINATION AND IRRADIATION EFFECTS AND THEIR DEPENDENCE ON THE COMPOSITION OF RESIDUAL GASES IN THE ELECTRON MICROSCOPE. Heide, H. G. (Max Planck-Gesellschaft, Berlin). Lab. Invest., 14: 1134-9(June 1965).

Exposure of objects in electron microscopes to molecules of residual gases is discussed. Damage to the specimen by electron-induced ionization, contamination of the specimen, composition of the residual gas, and importance of the residual gases in practice are discussed. (M.C.G.)

36494 INVESTIGATION IN THE FIELD OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION. V. SOLID STATE COPOLYMERIZATION OF N-VINYLSUCCINIMIDE AND N-VINYLPYRROLIDONE. (COPOLYMERIZATION IN SOLID AND SUPERCOOLED EUTECTICS.) Hardy, Gyula; Varga, Jozsef; Nagy, Gabor. Magy. Kem. Folyoirat, 71: 171-5(Apr. 1965). (In Hungarian)

The solid system of N-vinylsuccinimide and N-vinylpyrrolidone was characterized by an eutectic corresponding to the molar ratio of 3.4:6.6. The rate of copolymerization in the eutectic system was higher than in mixtures having any other initial composition. The composition of the resulting copolymer was the same as that of the eutectic in each case, and when prepared in the solid phase, it was different from the composition derived on basis of the relative reactivities. This fact proved that the structure of the resulting copolymer was determined by the physical structure of the two-component solid system. The rate of polymerization of the eutectic mixture in the supercooled liquid phase was even higher than in the solid state. The composition of the resulting copolymer was between the values obtained for products prepared in the liquid state and in the solid eutectic. (auth)

36495 INVESTIGATIONS IN THE FIELD OF THE RADIATION-INDUCED SOLID STATE POLYMERIZATION. VI. THE γ-RADIATION INITIATED SOLID PHASE POLYMERIZATION OF VINYL LAURATE. Hardy, Gyula; Nyitrai, Karoly; Varga, Jozsef; Patko, Marton. Magy. Kem. Folyoirat, 71: 175-8(Apr. 1965). (In Hungarian)

The γ initiated solid-state polymerization of vinyl laurate was characterized by the maximum value of the rate of polymerization near the melting point. Retardation of the polymerization was observable in the presence of inhibitors. It was concluded from a kinetic study of the postpolymerization and from the molecular weight of the polymers produced in the solid state that the molecules of the vinyl laurate were more mobile in solid state in the temperature range near the melting point than cetyl methacrylate or vinyl stearate, which had similar structures. (auth)

36496 ON THE POLYMERIZATION OF FORMALDEHYDE IN LIQUID STATE. I. GAMMA RAY-INITIATED POLYMERIZATION OF THE MONOMER IN SOLUTION. Nakashio, Seizo; Ueda, Mitsuo; Takahashi, Kei (Sumitomo Chemical Co., Ltd., Osaka). Makromol. Chem., 83: 23-34(1965).

The effects of dose rate, temperature, monomer concentration, and various additives on the polymerization of formaldehyde were determined. The polymerization rate was 10^3 to 10^5 times higher than that of conventional monomers (for example, styrene) at room temperature. Although ionizing radiation is known to be of low efficiency in causing ionic polymerization, the high rate of polymerization of formaldehyde could be ascribed to a difference between qualities of C=C and C=O bonds. Polymerization took place in toluene and ethyl bromide and within the range of 50 to 80°C. The overall reaction was ~ third-order with respect to the monomer. The average molecular weight of the polyoxymethylene obtained was little dependent on the initial concentration of the monomer and on dose rate. The reaction was ~ first order with respect to dose rate. It is suggested that the polymerization, in which the transfer process of growing chain to monomer is mainly responsible for governing the molecular weight, proceeds predominantly by an ionic mechanism. A study of the influence of various additives on the polymerization showed that these additives could be classified in four groups with respect to their qualities, the first group having influence only on the polymerization rate, the second only on the molecular weight, the third on both of these factors, and the last having no influence on these factors. The apparent activation energy was estimated to be 4.15 kcal/mole from rate of polymerization, −3.50 kcal/mole from average degree of polymerization. In the polymerization the system becomes jelly-like even after low conversions. (BBB)

36497 THE ELECTRON SPIN RESONANCE SPECTRA OF γ-IRRADIATED FUMARIC ACID. Cook, R. J.; Rowlands, J. R.; Whiffen, D. H. (National Physical Lab., Teddington, Eng.). Microtecnic, 19: 104-6(Apr. 1965).

Fumaric acid crystals were irradiated with γ rays of mean energy 1 Mev in a spent-fuel irradiation unit at doses up to 50 MRad at room temperature. The radical yield was lower than that for most aliphatic acids. The ESR spectra were measured at 9000 Mc/sec on a superheterodyne spectrometer. Three sets of spectra were obtained with the magnetic field perpendicular to X, Y, and Z axes in turn at 10° intervals. G factors were measured by determining the center of the pattern relative to an N′N′-diphenyl-N-picrylhydrazyl marker assumed to have G = 2.0036. The 0,0′-dideuterioacid was formed from deuterium oxide, and the nature of the exchange confirmed by IR spectroscopy. Irradiation gave rise to at least two radicals, one being in much higher concentration than the others. The most abundant radical showed hyperfine interaction with two H atoms. One coupling showed the characteristic anisotropy of an α-H and the other the more isotropic behavior of a β-H atom. The ESR spectra for the crystal rotations about the X and Z axes showed only one magnetically distinct site. Rotation about Y indicated two sites, persumably one in each of the twins. This indicates that the Y-axis is a principal direction for all tensors. The only plausible arrangement is that the fumaric acid molecules lie perpendicular to the b axis of the monoclinic cell and that the two ends of the molecule are related by this two-fold axis. The findings were consistent with a radical $R \cdot CH(CO_2H) \cdot CH(CO_2H)$ (I). Other radicals were present in too small an amount for precise analysis, but there was one species which consistently gave two lines outside those of radical I. The results were those to be expected for a radical containing one H atom attached to the free-radical center with a C−H bond parallel to the corresponding C−H of radical I. The findings were consistent with the radical, $CH_2(CO_2H) \cdot CH(CO_2H)$ (II). (TCO)

36498 ELECTRON SPIN RESONANCE OF X-IRRADIATED SINGLE CRYSTALS OF GLYOXIME. Kurita, Yukio; Kashiwagi, Michio; Saisho, Hideo (Toyo Rayon Co. Ltd., Tebiro, Japan). Nippon Kagaku Zasshi, 86: 578-85(June 1965). (In Japanese)

The ESR of x irradiated single crystals of glyoxime was measured at room temperature at 9 Gc/sec. From analysis of anisotropy in the spectra, the free radical produced by x irradiation was confirmed to be of the form R-CHNO. The principal values of the nuclear coupling constants for the nitrogen and hydrogen atoms are 39.9, 22.0, and 20.4 and 24.8, 21.4, and 19.9 gauss, respectively. The principal values of the g-factor are 2.0025, 2.0064, and 2.0118. The free radical is a planar non-π radical with the CNO angle

of about 142° and has a syn configuration with regard to the C–H and N–O bonds. About 41% of the unpaired electron is in an sp^2 hybrid orbital of the nitrogen atom directed along the bisector of the CNO angle. (auth)

36499 RADIOLYSIS OF Co(III)-EDTA IN AQUEOUS SOLUTION. II. EFFECTS OF SOLUTE CONCENTRATION AND pH ON G VALUE. Matsuura, Niro (Tokyo Univ.); Shinohara, Nobuyoshi; Takizawa, Masao. Nippon Kagaku Zasshi, 86: 590-3(June 1965). (In Japanese)

The chemical action of ^{60}C γ rays in aerated and deaerated solutions of Co(III)-EDTA was studied as functions of solute concentration [Co(III)-EDTA] and pH. G(–Co(III)-EDTA) in the dearated solutions increased with increasing [Co(III)-EDTA] (1×10^{-4} to 1.5×10^{-3} mole/l.), but was little affected by changing pH (0.4 to 5). In the aerated solutions a similar G(–Co(III)-EDTA) dependence on [Co (III)-EDTA] also appeared, and further degree of the dependence was affected by pH used; i.e., it became larger below pH 2 than above pH 3. The ultimate G(–Co(III)-EDTA), in the deaerated system was 4.5 which is independent of pH, but that in the aerated system was 2.6 at pH 0.4 ~ 2, sharply dropped at pH 2 ~ 3 and was 1.6 at pH 3 ~ 5. The most probable reactions for the decomposition of Co(III)-EDTA are proposed. (auth)

36500 FORMATION OF FISSION-XENON COMPOUNDS. Kamemoto, Yuichiro (Japan Atomic Energy Research Inst., Tokyo). Nippon Kagaku Zasshi, 86: 648-9 (June 1965). (In Japanese)

Fission-xenon compounds were prepared by neutron irradiation of mixture of uranium dioxide powder and lithium fluoride powder. The mixture was irradiated in the JRR-1 reactor for 1 day at a neutron flux of about 3×10^{11} n/cm^2/sec and cooled for 20 days. Then the mixture was placed at the bottom of a glass tube and heated at 450°C. The evaporated substances were deposited on the lower temperature portion of the glass wall. After cooling this tube, the glass wall was surveyed by a γ spectrometer. The activity due to ^{133}Xe was observed on it. After elementary xenon in the tube was removed by evacuating or blowing air, the tube was surveyed again. The presence of xenon activity after the elementary xenon had been removed, revealed the formation of xenon compounds. (auth)

36501 PARAFFIN BASE CHEMICAL DOSEMETER. Geissler, Karol; Krzywanska, Emilia. Nowotwory, 15: 97-100(Jan.-Mar. 1965). (In Polish)

Radiation effects produced by x and gamma rays of different energy in the system paraffin, chloroform, p-dimethylaminobenzene, in relation to the content of chloroform and radiation dose were investigated. Also the suitability of paraffins with different physicochemical characteristics for the preparation of a chemical dosimeter was investigated. (auth)

36502 SOME GRAFTING REACTIONS INVOLVING POLY(OLEFIN SULPHONES). Eaton, E. C. (Synthite Ltd., Birmingham, Eng.); Ivin, K. J. Polymer, 6: 339-42 (July 1965).

Some grafting reactions involving poly(olefin sulfones) were investigated. Conditions are described under which rather small amounts of poly(hexene-1 sulfone) may be grafted onto polyethylene and polypropylene, substantial amounts of poly(hexene-1 sulfone) may be grafted onto poly(cyclopentene sulfone), and substantial amounts of polystyrene may be grafted onto poly(butene-1 sulfone). In the last case AZBN as initiator gave a well-defined copolymer. (auth)

36503 THE CHEMICAL NATURE OF PHOTOREACTIVABLE LESIONS IN DNA. Setlow, Jane K.; Boling, M. E.; Bollum, F. J. (Oak Ridge National Lab., Tenn.). Proc. Natl. Acad. Sci. U. S., 53: 1430-6(June 1965).

The presence of thymine dimers in irradiated poly dA : dT and cytosine dimers in irradiated poly dI : dC, poly dG : dC, and poly dC is correlated with the ability of these substances to compete with transforming DNA for the photoreactivating enzyme. Heating polynucleotides that contain cytosine dimers converts the dimers to uracil dimers, and the resulting polymers also compete. All three types of dimers are monomerized by the photoreactivating enzyme, which also decreases the ability of the irradiated polymers to compete. Experiments on competing ability of irradiated DNA indicate that in the naturally occurring polynucleotides all these pyrimidine dimers also are substrates for the photoreactivating enzyme. (auth)

36504 SCINTILLATION PROCESS IN DPO-TOLUENE SOLUTION. Kato, Takesi (Osaka Univ.). Radioisotopes (Tokyo), 14: 193-8(May 1965).

The variation of fluorescence efficiency with concentration for 2,5-diphenyloxazole (DPO) and for carbon tetrachloride in the toluene was studied under aerated conditions. The ratio of the light yield in absence of a quencher, I_0, to that in its presence, I_Q at fixed solute concentration and at fixed radiation intensity for direct excitation of the solute by 302 mμ was found to follow the relationship $I_0/I_Q = (1 + K_2[Q])$, where [Q] is the quencher concentration and K_2 the quenching constant. The K_2 value obtained was 6 liters/mole. Under indirect excitation of DPO via primary excitation of the toluene by 260 mμ uv, the I_0/I_Q vs [Q] curve was found to be described by the Stern-Volmer relationship $I_0/I_Q = (1 + K_1[Q])\ (1 + K_2[Q])$, where K_1 is the quenching constant. The following values for zero concentration of DPO were obtained: $K_1 = 640$ liters/mole and $k_q = 2.5 \times 10^{10}$ liters/mole · sec, where k_q is the specific rate of quenching calculated from the relation $k_q = K_1/\tau'$, with τ' the decay time of the fluorescence in the quencher-free toluene solution. The specific rate, k_t of excitation transfer from toluene molecules to DPO molecules was determined from the observed relationship between fluorescence efficiency and DPO concentration; $k_t = 8.56 \times 10^{10}$ liters/mole · sec. The theoretical curves of the fluorescence efficiency vs DPO concentration based on the energy-exchange processes and the experimental values of rate constants were found to fit satisfactorily the experimental values of fluoresence except in the low concentration range. The disagreement seemed to be explained by the assumption that the solvent emission is absorbed by the solute molecules, giving solute fluorescence with quantum efficiency of about unity. The validity of the assumption should, however, be checked experimentally. The quenching constant K_1 under ^{60}Co γ excitation was larger by a factor of 2.2 than that under 260 mμ uv excitation. Similar experiments were carried out for p-terphenyl and the results are presented. (auth)

36505 RADIATION-INDUCED GRAFT COPOLYMERIZATION OF BUTADIENE TO POLYETHYLENE AND POLYPROPYLENE. Furuhashi, Akira; Kadonaga, Masao (Electrical Communication Lab., Tokyo). Rev. Elec. Commun. Lab. (Tokyo), 12: 755-66(Nov.-Dec.1964).

The polymer films were γ irradiated by a ^{60}Co source of 4000 C in a butadiene gas flow or liquid state. Irradiation dose rates, irradiation temperatures, and irradiation times were employed extending from 1.2×10^4 to 2.3×10^5 Rad/hr from 0 to 80°C, and from 2 to 46 hr, respectively. When the films were irradiated in a butadiene gas flow, the grafting ratio was directly proportional to the irradiation time except in the case of thin films. On the other hand, when the films were irradiated in liquid butadiene, the grafting ratio slightly leveled off for longer irradiation times, resulting in occluded butadiene homopolymer. When polyethylene (PE) was irradiated in a butadiene gas flow, the grafting rate increased with increasing film thickness. On the other hand, for the polypropylene (PP) butadiene grafting reaction the rate was higher for 0.03-mm than for 0.5-mm thick film. This indicates that, although the grafting reaction may be diffusion-controlled near the center of PP film, a predominant retardative effect on grafting appears near the PE film surface. When PE film was irradiated in liquid butadiene this effect decreased, and therefore graft copolymerization occurred almost homogeneously throughout the volume of the PE. When the films were irradiated in butadiene gas, the grafting rate increased with increasing irradiation temperature except for low density PE film. The rate showed a maximum value at 50–60°C. In the case of low density PE, the maximum value appeared at 20°C.

When the films were irradiated in liquid butadiene, the maximum grafting rate appeared at higher temperature than the case of the grafting reaction in the butadiene gas flow, due to the grafting rate constant being affected by the higher pressure of the system. From electron microscope studies, it was concluded that: the grafting reaction occurs predominantly on the surface of the crystallite (lamella) of PE; the grafting rate is not affected by the overall crystallinity of the trunk polymer, but the degree of branching or side-chain length; and each polymer radical has a different life, and consequently it affects the grafting rate differently. (TCO)

36506 HIGH-TEMPERATURE RADIOLYSIS OF PROPYLENE. Munari, Stelio; Castello, Gianrico (Universita, Genoa). Ric. Sci. Rend., Sez. A, 7: 637-46(Dec. 1964). (In Italian).

Irradiations of propylene were carried out at 250°C in stainless steel vessels. The average G of transformation of monomer was 666. Quantitative analysis of products was accomplished by gas-liquid chromatography and enabled separation of reaction products ranging from H_2 to C_{18} hydrocarbons. The main products were C_6 hydrocarbons, especially hexene-(1). A free radical chain reaction mechanism, based on a careful examination of reaction products, is proposed. (auth)

36507 NEW TECHNIQUES FOR RADIATION VULCANIZATION. Bennet, J. V.; Pearson, R. W. (Dunlop Rubber Co. Ltd., Birmingham, Eng.); Mills, I. G. Rubber Chem. Technol., 38: 94-102(Mar. 1965).

The effectiveness of reducing agents (increasing the yield of radicals and cross-links) as promoters in the high-energy radioinduced vulcanization of styrene-butadiene rubber (SBR) was examined. Also, the effects of impurities in SBR were considered, such as shortstop residues, soaps, trace metals, and antioxidants. The presence of the redox additive tetraethylene pentamine (TEP) increased the susceptibility of SBR's to radiation vulcanization, whether or not they had been extracted. The effect of soaps and soap residues was further tested by the addition of these materials to highly extracted black-loaded SBR stocks. While stearic acid and Dresinate soap had little effect on the vulcanization rate, the hydrolysis product of Dresinate soap increased the modulus of hexane diamine-activated SBR after exposure to a radiation dose of 2 MR. A satisfactory modulus was achieved by exposing unextracted SBR 1503, which had been treated with a combination of TEP and Dresinate soap hydrolysis product, to 3 MR irradiation. Addition of 1% by weight of Polygard had an adverse effect on the radioinduced cure in the presence of hexane diamine. A high concentration of copper ions (0.01%) reduced the amount of radioinduced crosslinking, but similar quantities of iron had little effect. The addition of sequestering agents (α, α'-dipyridyl or salicylic acid) to an iron-activated SBR reduced the rate of radiation vulcanization. The effect of dose rate on the radiation vulcanization of SBR was studied. Both activated and normal radiation cures are more effective at low-dose linking. The effects of various grades of carbon black on the modulus obtained by radiation vulcanization in the presence of TEP were investigated by irradiating a number of samples to 3 MR in vacuum. The wide variation in results indicated that chemical groups in the structure of carbon blacks, or trace chemicals adsorbed by them, participate in the crosslinking mechanism. No direct correlation was found between the efficiency of crosslinking and the properties of carbon black defined. The results described show that substantial reductions in the vulcanization dose are possible, and that satisfactory physical properties can be obtained by compounding with reducing agents. (TCO)

36508 RADIATION KINETICS OF ACCUMULATION OF ELECTRON CENTERS IN ALKALI-HALIDE CRYSTALS. Vaisburd, D. I.; Melik-Gaikazyan, I. Ya. (Tomsk State Univ., USSR). Teor. i Eksperim. Khim., 1: 190-200(Mar.-Apr. 1965). (In Russian)

It was established experimentally by the irradiation of LiF with protons that the accumulation kinetics of F centers is described by curves with a maximum and that the efficiency of the radiation chemistry reaction $F \rightharpoonup M$ increases with increased doses. General concentrations of F centers in isolated and bound conditions were also determined. The statistical distribution of F centers with respect to multiple F_i centers and the statistical distribution of dose with respect to the multiplicity of localization were analyzed for nonreversable processes responsible for the increase of the efficiency of the reaction $F \rightharpoonup M$. The kinetic equation for the accumulation of the stored energy with increased dose, which explains the observed experimental complex character of the kinetics of the radio-induced accumulation of F centers of LiF, was derived. It was shown that the accumulation kinetics of F and M centers can be determined. (tr-auth)

36509 STRUCTURE OF THE YELLOW SPECIES FORMED ON IRRADIATION OF o-METHYLBENZOPHENONE. A LONG-LIVED ENOL. Ullman, Edwin F.; Huffman, K. R. (American Cyanamid Co., Stamford, Conn.). Tetrahedron Letters, No. 23, 1863-7(June 1965).

It was previously reported that o-methyl- and o-benzylbenzophenones (Ia and Ib) undergo reversible photoenolization to give the corresponding enols, IIa and IIb. The occurrence of the reaction was demonstrated by incorporation of deuterium in the recovered ketone during irradiation in deuterio-methanol and by trapping experiments. A transient species (λ max 405 mμ) having ~10-sec lifetime was obtained on flash photolysis of Ib in cyclohexane and was assigned the enol structure IIb. Apparently conflicting results have been obtained on flashing solutions of o-methyl- or o-ethylbenzophenone (Ia or Ic) in isopropyl alcohol which lead to the formation of long-lived (>1 hr) yellow species (absorption at 340 to 440 mμ) to which were assigned the corresponding enol structures (IIa and IIc). Although the reported sensitivity of these yellow species toward oxygen appears consistent with the enol formulations, it seemed unlikely that II, which could gain considerable aromatic resonance energy by ketonization, could possibly survive in a hydroxylic solvent for this period of time. The mode of formation and chemistry of the yellow species was re-examined and evidence is presented that the compound derived from Ia is an intermediate (III) which is spontaneously oxidized to anthrone (IV). (TCO)

36510 INVESTIGATION OF THE PHENOMENOLOGICAL QUANTUM YIELD OF X-RAY CONDUCTIVITY OF CdS. Svechnikov, S. V.; Chalaya, V. G. (Inst of Semiconductors, Kiev). Ukr. Fiz. Zh., 10: 597-60(June 1965). (In Ukrainian)

The results are presented of an experimental measurement of the phenomenological quantum yield of x-ray conductivity of CdS single crystals, as well as of the change in the value of this yield depending on the bias lighting intensity. Similar dependences of the light quantum yield were taken on the same samples for comparison with the visible part of the spectrum. The measurements were taken under conditions of equal values of the coefficients of light and x-ray absorption $\mu_L = \mu_p$ (λ = 5100 Å and K_α - Cu). Samples were selected for measurement that could illustrate the theoretically calculated curves of the dependence of the light quantum yield on the bias lighting intensity for the following cases: there is an s-channel of recombination, the t-levels of trapping are slow; there is an s-channel, the t-levels are fast. Agreement of the experimental curves with the theoretical and similar curves for the light and x-ray dependences $G_f = f(L_{bias})$ were obtained for both cases. The absolute values of the measured light and x-ray phenomenological quantum yield are presented. The conclusion is drawn that a correlation exists between the photo and the x-ray conductivities. (auth)

36511 CHANGES OBSERVED IN MOLECULAR WEIGHT DISTRIBUTION OF POLY-ϵ-CAPROAMIDE AFTER γ IRRADIATION. Voitsekhovskii, R. V.; Polyakova, V. M.; Gorshechnikova, O. V. (Inst. of Chemistry of High-Molecular Compounds, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 31: 600-2(1965). (In Russian)

Industrial samples of poly-ε-caproamides were subjected to irradiation from a ^{60}Co γ source in sealed, evacuated ampules. The dose intensity was 280 Rad/min. The study included measurements of thermomechanical properties for the compression of samples at constant load, change in viscosity, and Huggins constants. The data indicate that cross linking is the principal process. This was also indicated by the reduction in solubility of poly-ε-caproamide in concentrated sulfuric acid. The molecular weight distribution was measured by an improved turbidimetric method. Calibration graphs plotted from solubility measurements of homogeneous fractions were used in making the calculations. Hydrochloric acid, 5N, was used as a solvent and a 3.8N aqueous solution of $(NH_4)_2SO_4$ as the precipitant. The results of measurements indicate that the increase in polydispersity of samples is due to the occurrence of higher as well as of lower polymer fractions. The straight line for Tung's distribution function breaks up into three segments of different slopes. This indicates simultaneous cross linking and destruction of macromolecules of poly-ε-caproamide during γ radiation. (ATD)

36512 RADIATION CROSSLINKAGE OF POLYELECTROLYTES BASED ON POLYACRYLAMIDE. Kholodova, Yu. D.; Sharpatyii, V. A.; Zakatova, N. V. (Inst. of Physiology, Academy of Sciences, Ukrainian SSR and Karpov Inst. of Physics and Chemistry, Moscow). Vysokomolekul. Soedin., 7: 795-801(May 1965). (In Russian)

The crosslinkage of polyacrylamide derivatives, copolymers of aminomethylamide, acrylic acid, and acrylamide, was investigated. Of the crosslinking methods studied, the most suitable was found to be radioinduced crosslinking, making it possible to prepare insoluble resins of varying degrees of swelling, depending on the radiation dose. Analysis of the EPR spectra and qualitative and quantitative analysis of the gases formed during the radiolysis process gave information on the intermediate radiolysis products of the electrolytes and on the radiation resistance of the latter. (auth)

36513 ON ELECTRON PRODUCTION IN γ-IRRADIATED FROZEN SOLUTIONS. Eiben, K.; Schulte-Frohlinde, D. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Physik. Chem. (Frankfurt), 45: 20-30(Apr. 1965). (In German)

Absorption spectra and relative color intensities of γ-irradiated frozen aqueous and alcoholic solutions were determined in relation to alkali concentration, dose, cation or anion addition, and electron capture. The dependence of the G-value for solvated electrons on the alkali concentration was measured. The results showed that for the appearance of electron production the molecular structure and solvent phase are decisive. (tr-auth)

36514 YIELDS OF REDUCING SPECIES IN AQUEOUS SYSTEMS IRRADIATED WITH THE RECOILS FROM THE $B^{10}(n,\alpha)Li^7$ REACTION. Henglein, A.; Asmus, K.-D. (Hahn-Meitner-Institut fuer Kernforschung, Berlin); Scholes, G.; Simic, M. Z. Physik. Chem. (Frankfurt), 45: 39-46(Apr. 1965).

Solutions of boric acid + nitrous oxide, containing either isopropanol, CD_3OH, or DCOONa were irradiated with thermal neutrons from a nuclear reactor. The yields of N_2, H_2, HD, and D_2 were measured. The experiments clearly indicated the presence of two reducing entities in the irradiated aqueous medium viz., the electron and a dehydrogenating species (hydrogen atom). The yields of the two species were measured at various scavenger concentrations. (auth)

36515 STIMULATED RADIATION FROM Er^{3+} IONS IN CaF_2. Voronko, Yu. K.; Zverev, G. M.; Prokhorov, A. M. (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 48: 1529-32(June 1965). (In Russian)

Stimulated radiation from Er^{3+} ions in CaF_2 in region of 1.7 μ due to transitions between the $^4S_{\frac{3}{2}}$ and $^4I_{\frac{9}{2}}$ levels was obtained. (auth)

36516 RADIATION EFFECTS ON THE BAUXITE AND HYDRARGILLITE LEACHING RATE. Koryukov, V. N.; Kuznetsov, S. I.; Derevyankin, V. A. (Kirov Ural Polytechnic Inst., USSR). Zh. Prikl. Khim., 38: 746-50(Apr. 1965). (In Russian)

Ultraviolet and x-ray beams increased the leaching rate of bauxite and hydrargillite in alkaline aluminate solutions. The leaching rate increased with increasing duration of the exposure. The greatest effect of the irradiation was found when the bauxite and hydrargillite were exposed together with aluminate solutions during leaching or before leaching. (tr-auth)

36517 GAMMA IRRADIATION OF MONONUCLEOTIDES. Fischer, Siegmund; Ohlbaum, Adela (Universidad de Chile, Santiago). pp 19-23 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish)

By gamma irradiation of guanylic acid in aqueous solutions a material was obtained which corresponds to a polymer judging by the following criteria: behavior in DEAE column chromatography; hypochromic effect obtained by alkaline and enzymatic hydrolysis of the polymers; behavior in dialysis; and less migration of the irradiated product in DEAE cellulose paper chromatography, if compared with the mononucleotide. Preliminary results show that these polymers have a length and specificity of a phosphodiesteric linkage as shown by the incorporation of the specific amino acid to the subcellular fractions of yeast and of reticulocytes. (auth)

36518 DOSE-RATE EFFECT ON THE RADIOLYSIS OF MONO- AND DIIODOTYROSINE. Barzelatto, J.; Pinter, J.; Behrens, H.; Ojeda, S.; Palma, T. (Universidad de Chile, Santiago). pp 25-30 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

The results of a study of the effect of gamma radiation on aqueous solutions of mono- and diiodotyrosine of various acidities are presented, and an attempt is made to correlate these results with the effect of the possible presence of solvated electrons. The works of Yalow, and of Yalow and Berson on mono- and diiodotyrosines subjected to x irradiation suggests the presence of both oxidative and reductive processes, one of which predominates under certain conditions. Thus they suggest that above a 10^{-3} M concentration of the iodinated compounds, even in air, a reductive process is still apparent, though the oxidative process seems to predominate at lower concentrations. The results of these authors were obtained at a pH of 2.4, in the presence of HCl. Only one group gave a cursory treatment of the effect of pH. The kinetics of deiodination under various conditions of acidity by the use of gamma radiation from a cobalt-60 source are reported. The results obtained with gamma radiolysis suggest that the more diluted the solution, the higher the percentage of deiodination i.e., the higher the concentration, the smaller the percentage of decomposition with a given dose. This relation has not previously been found in these systems. Furthermore, the type of curves obtained by plotting G_0 (initial G value for decomposition), against initial concentration of iodinated products is, with gamma radiation, a positive parabole, whereas with x rays it reaches a saturation value. This is rather difficult to explain, except by assuming a type of recombination process in the latter case. The results of the study of deiodination by visible light of one of these diiodotyrosine molecules is comparable to that of the tyronines. The effect of H_2O_2 and I_2 has also been studied, as well as the general effect of visible light on the diiodotyrosine molecule. The results are compatible only with the admittance of deiodination by a solvated electron. This possibility is discussed. (auth)

36519 STABILIZATION OF ORGANIC FLUIDS AGAINST RADIATION DECOMPOSITION AND SYSTEMS EMPLOYING SAME. Ellard, James A. (to Monsanto Co.). U. S. Patent 3,184,390. May 18, 1965. Filed Oct. 24, 1960.

Radiolytic damage to systems of nonfused ring polyphenyls used in nuclear reactors can be inhibited by addition of bitumens from the class consisting of asphalt, coal

tar, and petroleum residuum. Not more than 50% by weight of bitumens should be used, preferably 5–25%. Use of the composition patented in a typical power reactor as moderator and coolant is illustrated. (A.G.W.)

36520 IMPROVEMENT OF THE ACTIVITY OF PALLADIUM HYDROGENATION CATALYSTS BY HIGH ENERGY IRRADIATION. Graham, Donald P. (to E. I. du Pont de Nemours and Co.). U. S. Patent 3, 189,561. June 15, 1965. Filed Jan. 12, 1961.

The activity of carbon-supported Pd hydrogenation catalysts is improved by irradiation with any of the following: 1.5-3 Mev of β radiation in dosage of 2000-30,000 w-sec/cm^2; 1.5-3 Mev of x radiation in dosage of 1×10^5 to 1×10^7 Rep; neutrons in dosage of 1×10^{16} to 1×10^{17} n/cm^2; or deuterons at 15 Mev and 20 μamp for 20-40 sec. High-energy radiations affect the crystal structure of the catalyst by producing additional active centers necessary for the catalytic hydrogenation reactions. (A.G.W.)

36521 IMPROVEMENT OF THE ACTIVITY OF NICKEL HYDROGENATION CATALYSTS BY HIGH ENERGY IRRADIATION. Graham, Donald P. (to E. I. du Pont de Nemours and Co.). U. S. Patent 3,189,562. June 15, 1965. Filed Jan. 12, 1961.

The activity of Ni hydrogenation catalysts is improved by irradiation with 1.5-3 Mev of β radiation in a dosage of 5-60 w-sec/cm^2 or 1.5-3 Mev of x radiation in dosages of of 1×10^5 to 1×10^7 Rep. The catalyst may be either the type of Ni catalyst supported on diatomaceous earth or the Raney Ni catalyst. Activity was increased 14-31% by β irradiation and as much as 26% by x irradiation. (A.G.W.)

Radiochemistry

See also Separation Processes and Procedures.

Refer also to abstract 36876.

36522 (DP-962) PURIFICATION OF ^{244}Cm AND ^{250}Cf–^{252}Cf FOR RADIATION PROPERTY MEASUREMENTS. Holcomb, H. Perry (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr. 1965. Contract AT(07-2)-1. 13p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Curium-244 was purified by cation exchange chromatography with ammonium α-hydroxyisobutyrate as the elutriant. The ~8 mg of purified ^{244}Cm contained only 0.2 wt % ^{243}Am and 1×10^{-7} wt % ^{250}Cf-^{252}Cf. An additional cycle of cation exchange chromatography with 0.2 mg of the purified ^{244}Cm decreased the ^{243}Am concentration to 9×10^{-4} wt % and the ^{250}Cf-^{252}Cf to $<1 \times 10^{-9}$ wt %. α and γ spectral analyses showed the ^{244}Cm to be radiochemically pure. Only low concentrations of nonradioactive impurities were found by emission spectrographic analyses. About 2.4 nanograms of ^{250}Cf-^{252}Cf was purified by cation exchange chromatography, anion exchange, and solvent extraction. The purified ^{250}Cf-^{252}Cf was radiochemically free of plutonium, americium, and curium. An undetermined amount of ^{249}Bk was probably present, but it contributed insignificant α, γ, and neutron radiations. No γ-emitting impurities were detected by γ spectral analysis. (auth)

36523 PREPARATION AND USE OF LEAD-212 TRACER. Sill, Claude W.; Willis, Conrad P. (U. S. Atomic Energy Commission, Idaho Falls, Idaho). Anal. Chem., 37: 1176-8(Aug. 1965).

Two hundred grams of 13-year-old thorium nitrate gave approximately 8.5×10^6 cpm of 212 Pb tracer. Thorium nitrate was converted to perchlorate and the lead extracted by the dithiocarbamate method. The relatively short-lived 212 Pb can be used in tracer studies. (F.J.H.)

36524 SYNTHESIS OF ^{14}C-LABELED PHOSPHOLIPIDS. Rehbinder, Dietrich; Greenberg, David M. (Univ. of California, San Francisco). Ann. Chem., 681: 182-7(1965). (In German)

Ethanolamine-(1,2-^{14}C) was converted to N-carbobenzoxyethanolamine-(1,2-^{14}C) in ether at 0°C to room temperature in 72% yield. This was converted in 37% yield (based on ethanolamine) to L-1,2-dipalmitoylglycerine-3-phosphoric acid mono(2-aminoethyl(1,2-^{14}C)ester) by adding it to a previously prepared solution of the acid chloride from $POCl_3$ and D-α,β-palmitin in chloroform at 0°C, in the presence of pyridine and chromatographing on a silica column: sp act. 1.8 mC/mm from 5 mC/mmol ethanolamine diluted to 2 mC/mmol; radiochemical purity, 88%. Another sample was purified on DEAE-cellulose and had sp act. of 1.9 mC/mmol. Labeled L-serine(1,2,3-^{14}C) was converted into N-carbobenzoxy-L-serine(1,2,3-^{14}C) by a procedure similar to that for the ethanolamine in 76% yield. This was converted to the cyclohexylammonium salt by addition of cyclohexylamine in methanol. The salt was converted to the benzyl ester with benzyl chloride and triethylamine at 95°C in 79% yield. This was converted to L-1,2-dipalmitoylglycerine-3-(phosphoric acid-mono-L-serine(1,2,3-^{14}C)ester) in the same way as the ethanolamine compound was prepared. Column chromatography on silica or DEAE cellulose was used to purify the produce, giving 26% yield based on serine, 1.7 mC/mmol, radiochemical purity 85% from the silica column; activity of 1.9 mC/mmol, 94% purity from the cellulose column. (BBB)

36525 OPTIMUM SPECIFIC γ ACTIVITY OF QUASI-HOMOGENEOUS RADIOCHEMICAL APPARATUS. El'tekov, V. A. At. Energ. (USSR), 18: 650-3(June 1965).

A graphical method was suggested for determining the optimum specific activity of sources and for selecting minimum cost isotopic preparations c/q (where c/q is the cost per unit of product) for a quasi-homogeneous radioactive apparatuses. The graphs are constructed from the minimum cost value c/q, the curve of log y_E (y is the source dosage), and the log 1 + s/a (a is specific activity). (R.V.J.)

36526 NOTE ON THE PREPARATION OF (1-^{14}C) SERINE. Schoeberl, Alfons; Pape, Christa-Vera (Chemisches Institut, Tierärztliche Hochschule, Hanover). Chem. Ber., 98: 1688-90(1965). (In German)

A solution of 33 mg K^{14}CN in 10 ml was mixed with 100 mg N-chloromethylphthalimide in 5 ml dioxane and allowed to stand 16 hr at 5°C. The quantitative yield of phthalyl-(1-^{14}C)-glycinenitrile was washed, dried, and dissolved in 5 ml methanol into which HCl was passed for 10 hr. The reaction mixture was evaporated and taken up in ether and 0.1N Na_2CO_3, yielding from the ether layer and combined washings a 98% yield of phthalyl-(1-^{14}C)-glycine methyl ester. This was dissolved in 5 ml methyl formate and treated, with ice cooling, with 0.5 ml of a suspension of 5 mmole $NaOCH_3$ in 2.5 ml xylene; the solution was let stand for 16 hr at 5°C and decomposed with benzene and 0.1 ml acetic acid, stirred and treated with 8 ml 1N HCl. The benzene layer and washings yielded after extraction with water, drying, and evaporation an 87% yield of phthalimidoformyl-(1-^{14}C)-acetic acid methyl ester. Treatment of 96 mg of the latter in 25 ml 80% aqeuous dioxane with 16.3 mg $NaBH_4$ in 10 ml of 80% aqueous dioxane added over 30 min yielded, after stirring 2 hr and decomposition with 2N HCl, the crystalline product after evaporation of the solvent. This was shaken with benzene 12 hr and washed three times; evaporation gave 82% methyl α-phthalimido-β-hydroxy-(1-^{14}C)-propionate. The product was refluxed with 10 ml 20% HCl 16 hr; the phthalic acid centrifuged off; and the solution concentrated to 3 ml and put on a 6 × 0.5 cm column of Dowex 50 × 8 in acid form. The eluate was removed with 0.2N ammonia, giving DL-serine. This was converted to the N-chloroacetyl derivative and resolved with acylase I. (BBB)

36527 LIQUID SCINTILLATION COUNTING OF $H_2S^{35}O_4$ WITH GLASS FIBRE PAPER. Lloyd, R. A.; Rees-Evans, D. B. (Wantage Research Lab., Berks, Eng.). Intern. J. Appl. Radiation Isotopes, 16: 393-6 (July 1965).

A method of preparing sources of $H_2S^{35}O_4$ for liquid scintillation counting is described, and shown to provide

improved reproducibility. The sources are prepared on glass fiber paper by the use of a ring oven. Reproducible paper loading, obtained by using a micro-capillary pipette permitted the determination of consistent self-absorption curves. It is shown that $Li_2{}^{35}SO_4$ gives less satisfactory results, and it is suggested that this method of counting an anion in its acid form rather than as a salt, could be widely applicable. It was particularly convenient when the acid was provided directly from an ion-exchange column. (auth)

36528 COMPUTER PROGRAMS FOR CALCULATION OF LIQUID SCINTILLATION COUNTING DATA. Spratt, J. L. (Univ. of Iowa, Iowa City). Intern. J. Appl. Radiation Isotopes, 16: 439-41(July 1965).

Computer programs were written in FORTRAN IV language to calculate disintegrations per minute and quench corrections for liquid scintillation counting data. They may be used for either manually punched or automatically punched IBM cards. Each program will accommodate an infinite number of counting jobs with up to 200 samples per job. (auth)

36529 PRODUCTION OF SHORT-LIVED ISOTOPES (WITHOUT CHEMICAL PROCESSING), OF ^{32}P AND ^{35}S IN THE LABORATORY OF RADIOCHEMISTRY OF THE INSTITUTE OF PHYSICS, ATOMIC RESEARCH CENTER, ANEB. Nikolov, K.; Mihailov, M. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk, 13: 25-30(1965). (In Bulgarian)

The scientific experimental reactor IRT-1000 offers the best opportunity for the production chiefly of short-lived radioactive isotopes. In this connection, information is given on the production of short-lived isotopes at the Laboratory of Radiochemistry of the Institute of Physics, Atomic Research Center. The method used and the equipment of a box for the production of ^{32}P labeled phosphates are reported, as well as the method developed and the apparatus designed for the production of ^{35}S as carrier-free sulphuric acid. (auth)

36530 APPARATUS FOR PRODUCTION OF COLLOIDAL RADIOGOLD. Karaivanov, I. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk, 13: 157-61(1965). (In Bulgarian).

An apparatus for the production of radioactive colloidal gold for medical purposes is described. The apparatus was designed for the production of colloidal gold according to the following pattern: dissolution of aqua regia, repeated evaporation with hydrochloric acid and water, extraction of the auric chloride acid with water neutralization, and reduction to metallic gold in a colloidal form. The irradiated metallic gold is pneumatically introduced into the apparatus. (auth)

36531 CARRIER-FREE (7-^{3}H)-TESTOSTERONE. Coombs, M. M.; Roderick, H. R. (Imperial Cancer Research Fund, London). Nature, 203: 523(Aug. 1, 1964).

Carrier-free (7-^{3}H)-testosterone acetate was prepared by catalytic reduction in pure tritium of 17-β-acetoxy-androstan-4,6-dien-3-one, as follows. Δ^6-testosterone acetate was prepared by dehydrogenation of testosterone acetate with chloranil in tert-butanol. The use of 2,3-dichloro-5,6-dicyano-p-benzoquinone catalyzed with HCl gave the dienone more conveniently and in better yield though mixed with about 10% of the 1,2-unsaturated isomer. However, this was unacceptable because chromatographic separation of testosterone acetate and its Δ^1- and Δ^6-unsaturated derivatives proved very difficult. The reactivity with respect to catalytic hydrogenation in neutral solution of the sterioidal 4,5-double bond is exceeded only marginally by that of the 6,7-double bond, and this difference can be increased by conducting the reaction in anhydrous methanol in the presence of a small but critical concentration of alkali. A 60-mg sample of Δ^6-testosterone acetate was reduced in carrier-free ^{3}H gas to give testosterone acetate showing no selective absorption at 284 mμ in its uv spectrum. This material was saponified with 0.2N alkali in aqueous methanol and the resulting testosterone separated from saturated steroids by paper chromatography (Whatman No. 1 paper; 19:1 isooctane-toluene/80% aqueous methanol), the zones being detected by autoradiography. The testosterone was eluted from the paper and shown by uv spectroscopy and carrier-dilution analysis to have a sp act. of 30.8 C/mmole. This value is consistent with the formulation of the product as (7-^{3}H)-testosterone, having arisen from the initially formed (6,7-$^3H_2$)-testosterone, by loss of the 6-tritium atom through enolization. (BBB)

36532 RADIOCHEMICAL SURVEY OF THE ELEMENTS. Principal Characteristics and Applications of the Elements and Their Isotopes. Haissinsky, M.; Adloff, J.-P. Translation by Express Translation Service of Dictionnaire Radiochimique des Elements. New York, [American] Elsevier Publishing Company, 1965. 185p. $12.00.

The radiochemical properties of the elements are discussed. Nuclear, chemical, and physical properties are described for each of the elements and their isotopes. (F.J.H.)

36533 IMPROVEMENTS IN AND RELATING TO LUMINESCENT MIXTURES AND AN ORGANIC COMPOUND FOR USE THEREIN. Lenze, Eberhard (to Trilux Lenze K.-G.). British Patent 991,017. May 5, 1965. Priority date Apr. 26, 1960, Germany.

A luminescent mixture constituting a self-illuminating light source consists of a luminescent material dispersed in a polymer having chemically incorporated tritium. The tritium is incorporated into the polymer by subjecting the polymer in an atmosphere of tritium at pressures in the range 100-700 mm Hg to an electric discharge or to an ionizing radiation other than that of the tritium. Electric discharges generally produce higher tritium yields than radiation, but they cannot be used with some compounds whose structure is destroyed by them. The compound treated may be an intermediate compound used in preparing the polymer or the polymer itself before or after mixture with the luminescent material. (A.G.W.)

36534 PROGRESS FOR REMOVING RADIOACTIVE IMPURITIES FROM GASES. Baldus, Wolfgang; Lehmer, Wilhelm (to Gesellschaft fur Linde's Eismaschinen Aktiengesellschaft). U. S. Patent 3,179,487. Apr. 20, 1965. Priority date Dec. 2, 1958, Germany.

A process is described for the purification of a gas mixture containing radioactive impurities and H_2 and CO as non-radioactive impurities includes the oxidation of only the non-radioactive components with the aid of a catalyst to convert the H_2 and CO to water and CO_2, which are then separated by condensation and adsorption at a temperature in the range of 0 to −70°C. The radioactive impurities are adsorbed on a suitable adsorption agent at a temperature below −70°C. A number of adsorbing units containing an adsorptive gel, active charcoal, microfilters, or the like are successively switched into the gas stream until they are used up. The spent adsorber is then left in the pile until such time as the radioactivity has diminished to a level at which the adsorber can be removed for disposal or regeneration. The purified gas stream is led back to the pile for recirculation. (B.L.M.)

Separation Processes and Procedures

See also Analytical Procedures.
ISOTOPE TECHNOLOGY — Separation and Production

Refer also to abstracts 36593 and 36680.

36535 (HW-84609(p.4.1-7)) CHEMICAL RESEARCH AND DEVELOPMENT. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Work on the salt cycle process is summarized. Results

are included on PuO_2 precipitation, and spectrophotometry of Pu in chloride melts. Development of processes for radioactive residues is described. Program planning for containment systems experiments is summarized along with work on containment test facility equipment, instrumentation, fission product simulation, and aerosol generation and sampling. (J.R.D.)

36536 (IS-T-32) EQUILIBRIUM DATA FOR THE TBP–D2EHPA–$Nd(NO_3)_3$–HNO_3 SYSTEM (thesis). Chittenden, Jimmie Alan (Ames Lab., Iowa State Univ. of Science and Tech.). July 1965. Contract W-7405-eng-82. 28p. Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

Neodymium nitrate was extracted from aqueous solutions using pure di-(2-ethylhexyl) phosphoric acid (D2EHPA) and mixtures of D2EHPA with tributyl phosphate (TBP). Pure undiluted D2EHPA was used in the extraction studies to remove the influence of a diluent upon the behavior of the solvent extraction system. The use of undiluted D2EHPA on an industrial scale appears to be impractical because of slow phase separations, viscous organic phases at high lanthanide concentrations, and the possibility of the formation of a gelatinous third phase with increased lanthanide concentrations in the organic phase. No striking synergic increases in the distribution coefficient were noted in the extraction of $Nd(NO_3)_3$ using mixtures of D2EHPA and TBP. At concentrations of less than 0.3M $Nd(NO_3)_3$ in the aqueous phase, TBP had a significant depressing effect upon the extraction by D2EHPA. At concentrations higher than 0.3M $Nd(NO_3)_3$, TBP reinforced the extraction by D2EHPA and gave distribution coefficients slightly higher than the weighted average of the distribution coefficients of the individual pure organic solvents. As expected, the addition of nitric acid to the initial aqueous phase caused a reduction in the extraction capabilities of D2EHPA. The result of adding nitric acid to the TBP–D2EHPA–$Nd(NO_3)_3$–H_2O system was to reduce the antisynergic effect of the TBP upon the D2EHPA when extracting from low-concentration aqueous neodymium solutions. (auth)

36537 (LA-DC-7066) PROCESSING OF PLUTONIUM BY ION EXCHANGE. VI. PLUTONIUM(IV) SORPTION KINETICS ON DOWEX 1X4 FROM NITRATE SOLUTIONS. James, D. B. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). 1965. Contract W-7405-eng-36. 30p. (CONF-650902-3) Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

For Presentation at American Chemical Society, 150th National Meeting, Atlantic City.

Sorption rates from various nitric acid and mixed aluminum nitrate–nitric acid solvents were studied. The particle-diffusion controlled reaction proceeds with an apparent average diffusion coefficient which decreases exponentially with increasing plutonium sorption. The results agree reasonably well with a computer solution of Fick's Law with the local, intra-particle diffusion coefficient proportional to the local, intra-particle fraction of unreacted exchange sites. The trace-sorption diffusion coefficient is strongly dependent upon the composition of the aqueous phase, and is empirically shown to be roughly inversely proportional to the product of the trace-sorption distribution coefficient and the ratio of the hydronium ion to water concentrations. These kinetic results and previously reported equilibrium parameters may be coupled with the fundamental partial-differential equation which describes the operation of a fixed-bed, anion-exchange column to allow computer optimization of plant-scale processing equipment. The effects of the variation of such parameters as volume and mass flow rate, temperature, plutonium feed concentration, and macro concentrations of aluminum nitrate in the feed are discussed. (auth)

36538 (MLM-1233J) HYDROLYTIC SEPARATIONS OF PROTACTINIUM. Kirby, H. W. (Mound Lab., Miamisburg, Ohio). Dec. 28, 1964. Contract AT(30-1)-Gen-53. 13p. (CONF-650701-1) Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Colloquium on Physical Chemistry of Protactinium, Paris.

Milligram amounts of protactinium-231 can be separated from its decay products, actinium-227, thorium-227, and radium-223 by hydrolysis from 1N and 6N hydrochloric acid. Separation from milligrams of thorium is accomplished by hydrolysis in 1N nitric acid and from niobium by hydrolysis in a mixture of oxalic and hydrochloric acids. Iron is separated by selective dissolution of its hydroxide in dilute hydrochloric acid. Micrograms of protactinium are separated from its decay products by adsorption on glass wool from a dilute sulfuric acid solution and by the method of residue adsorption and selective desorption from a gold surface. The application of the adsorption technique to the problem of "inextractable polymers" is discussed briefly. (auth)

36539 (MLM-1234J) PURIFICATION OF PROTACTINIUM FROM NATURAL SOURCES. Kirby, H. W.; Figgins, P. E. (Mound Lab., Miamisburg, Ohio). [Dec. 28, 1964]. Contract AT(33-1)-Gen-53. 11p. (CONF-650701-2) Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Colloquium on Physical Chemistry of Protactinium, Paris.

Purification of protactinium was based on the assumption, subsequently found valid, that a procedure which quantitatively separated niobium would effectively eliminate most, if not all, other impurities. Protactinium was separated from ten times as much niobium by selective precipitation from oxalic–hydrochloric acid mixtures. Data are presented which show that the stability of the niobium oxalate complex is 100 times as great as that of protactinium oxalate. The addition of hydrochloric acid, by repressing the ionization of oxalic acid, greatly reduces the solubility of protactinium while having relatively little effect on that of niobium. The final product, obtained by dissolution and recrystallization of protactinium from concentrated sulfuric acid, contained 0.5 microgram of niobium per milligram of protactinium. A solution containing 90 mg/ml of protactinium in approximately 5N sulfuric acid has shown no hydrolysis or gel formation after more than four years. (auth)

36540 (NAA-SR-10485) A ROTARY KILN FOR THE CONTROLLED OXIDATION OF UC. Strausberg, S. (Atomics International, Canoga Park, Calif.). June 30, 1965. Contract AT-11-1-GEN-8. 26p. Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

A rotary kiln was evaluated for the controlled oxidation of UC. The rotating kiln was 16 in. in diameter by 21 in. long and made of stainless steel. It was rotated at 8 to 10 rpm. The oxidation was followed by measurement of temperature of the charge and CO_2 concentration in the off-gas. The kiln performed satisfactorily. Several 10-kg batches were oxidized at a rate of 2 to 2½ kg/hr at 400 to 500°C. Over 95% of the product was −200 mesh U_3O_8 when the starting material was reactive UC. This material is considered suitable feed material for reconversion to UC. (auth)

36541 (NAA-SR-10486) PREPARATION OF UC BY CARBOTHERMIC-REDUCTION OF U_3O_8. Strausberg, S. (Atomics International, Canoga Park, Calif.). June 30, 1965. Contract AT-11-1-GEN-8. 35p. Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

A two step method was developed for the preparation of UC by carbothermic reduction of U_3O_8. The reactions are: (1) $U_3O_8 + C \rightarrow 3UO_2 + CO_2$ (800 to 900°C) and (2) $UO_2 + 3C \rightarrow UC + 2CO$ (>1300°C), or overall, $U_3O_8 + 10C \rightarrow 3UC + 6CO + CO_2$. Success of the process depends on complete reduction of U_3O_8 to UO_2 at the lower temperature. Studies of the gas evolved during the low temperature step showed small amounts of CO were produced. Also, about 10.02 moles of carbon are required for each mole of U_3O_8 to produce stoichiometric UC. The additional carbon is consumed in the formation of some CO during the low-temperature step. The preparation of kilogram quantities of hypostoichiometric UC presented some difficulties in oxygen removal. Temperatures of 1800 to 1900°C are required to lower the oxygen content below 500 ppM and carbon pickup from the crucible and uranium metal vaporization changes

the product composition. However, it appears that UC suitable for recycle can be prepared by this method. (auth)

36542 (ORNL-P-971) STUDIES OF THE BEHAVIOR OF PROTACTINIUM IN SULFURIC ACID. Campbell, D. O. (Oak Ridge National Lab., Tenn.). Jan. 8, 1965. Contract W-7405-eng-26. 13p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

Studies of the chemistry of protactinium in sulfuric acid solutions were continued, utilizing primarily the solvent extraction method. Emphasis has been placed on the behavior at relatively high protactinium concentrations, up to several mg/ml. Data is reported for extractions into 0.03M trilaurylamine from 2.5, 3.2, and 4.17M sulfuric acid. In all cases a reasonably constant extraction coefficient is observed if the protactinium concentration in the aqueous phase is below about 0.004 mg/ml, but at higher concentrations extraction increases sharply. Above 0.01 mg/ml consistent extraction coefficients are observed for the higher acid concentrations, but for 2.5M acid results are not reproducible. Rates of extraction are very slow for the higher protactinium concentrations. The change in extraction behavior with protactinium concentration is interpreted in terms of the existence of several species which are probably polymeric in protactinium. At least two of these are extractable, but the species formed at higher protactinium concentrations are inextractable although they reach equilibrium with the extractable species very slowly. (auth)

36543 (TID-21955) FIXATION OF CESIUM 137 BY SOIL CLAYS. Progress Report, 1962-1965. (Connecticut Agricultural Experiment Station, New Haven). Contract AT(30-1)-2955. 8p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

The sorption of Cs from dilute solutions by silicate minerals, resins, and clay minerals in the presence of different competing cations was studied. The sorption of Cs by illite–vermiculite mixtures was studied in detail, and the effects of Al-interlayers were considered. Al-interlayers were determined by means of titration curves of H-saturated soil clays, Al salt solutions, H- and Al-saturated montmorillonite, and H- and Al-saturated resin. Kinetics of Cs sorption by illite and vermiculite were also studied. (D.L.C.)

36544 (TID-22034) STUDY OF THE USE OF ELECTRONICALLY EXCITED OXYGEN FOR THE DECOMPOSITION OF REACTOR MATERIALS. Gleit, C. E.; Holland, W. D.; Bersin, R. L. (TRACERLAB, Richmond, Calif.). Nov. 30, 1964. Contract W-7405-eng-26, Subcontract 2265. 62p. Dep.(mn); $3.00(cy), 2(mn) CFSTI

An evaluation was made of the feasibility of using electronically excited gases to oxidize graphitic reactor fuel elements at relatively low temperatures. The electronic ashing method and the parameters of the oxidation process are discussed. It is concluded that an electronic ashing system using CO_2 to burn spent fuel elements appears feasible. (D.L.C.)

36545 ION EXCHANGE SEPARATION OF AMERICIUM AND CERIUM. Perdue, Hazel D.; Hicks, Harry G. (Univ. of Calif., Livermore). Anal. Chem., 37: 110-12(Aug. 1965). (UCRL-12353)

Tracer quantities of ^{241}Am (10^5 disintegrations per minute) and 30 mg of cerium were separated quantitatively using Dowex 50W X12, 100- to 200-mesh, ion exchange resin and ammonium lactate as the eluant. Small columns were used, and the use of a fraction collector was eliminated. (auth)

36546 SEPARATION OF PROTIUM AND DEUTERIUM FORMS OF CARBOHYDRATES BY GAS CHROMATOGRAPHY. Bentley, Ronald; Saha, Nripendra C.; Sweeley, Charles C. (Univ. of Pittsburgh). Anal. Chem., 37: 1118-22(Aug. 1965).

Gas-liquid chromatography on 15- to 25-meter, narrow-bore packed columns of SE-30 and other liquid phases brought about the complete separation of trimethylsilyl derivatives of β-glucose from β-glucose-d_7. Partial separations were achieved with the α anomers of glucose and glucose-d_7, and with the α and β anomers of other pairs of protium and deuterium sugars. Structural factors appeared to play a significant role in these separations. It was calculated that columns with 200,000 theoretical plates would give complete resolution of all the protium-deuterium pairs studied (ribose, xylose, fucose, rhamnose, mannose, and glucose). (auth)

36547 LIQUID-LIQUID EXTRACTION OF ZIRCONIUM-(IV) WITH MESITYL OXIDE. Khopkar, S. M.; Dhara, S. C. (Indian Inst. of Tech., Bombay). Anal. Chem., 37: 1158-9 (Aug. 1965).

The concentration of mesityl oxide was varied from 19 to 100% with methyl isobutyl ketone as the diluent. The effect of the extraction was noted at different acidities in the presence of 4M sodium nitrate. Dilution of mesityl oxide lowered the extraction. A plot of log D vs log C mesityl oxide at 3 and 5M nitric acid indicated slopes of 2.4 and 1.6, showing the extractable species to be $Zr(NO_3)4.2MeO$ and $H[Zr(NO_3)_4(MeO)_2]$, respectively. The system conformed to the limiting square law in the case of zirconium-(IV). The optimum reagent concentration was 100%. (F.J.H.)

36548 ANION-EXCHANGE BEHAVIOR OF RARE EARTHS, THORIUM, PROTACTINIUM AND URANIUM IN THIOCYANATE-CHLORIDE MEDIA. Hamaguchi, Hiroshi; Ishida, Koji; Kuroda, Rokuro (Tokyo Kyoiku Univ.). Anal. Chim. Acta, 33: 91-7(July 1965).

The anion exchange of rare earths(III), thorium(IV), protactinium(V), and uranium(VI) from thiocyanate–chloride media was investigated. The equilibrium distribution study showed that the rare earths(III) and yttrium(III) were not significantly adsorbed on a basic anion-exchange resin, while thorium(IV), protactinium(V), and uranium(VI) were strongly adsorbed. Adsorption from the thiocyanate–chloride solutions was in the order, U(VI) > Pa(V) > Th(IV). The separation of rare earths(III) or yttrium(III), thorium (IV), protactinium(V), and uranium(VI) was successfully accomplished by column elution in thiocyanate–chloride media. A rapid and effective ion-exchange method for separating protactinium-233 from irradiated thorium(IV) is also presented. (auth)

36549 SEPARATION OF RADIOACTIVE ISOTOPES FROM WASTE WATERS. Rauzen, F. V.; Solov'eva, Z. Ya. At. Energ. (USSR), 18: 623-6(June 1965).

Studies of radioisotope separation from waste waters by coagulation and ion exchange showed that consecutive use of these methods reduced the activity of the waste solutions to permissible levels. It was shown that ion exchange separation of radioisotopes from the waste solutions is a direct function of the salt content in the solution. (R.V.J.)

36550 NUCLEAR FUELS. Amazawa, Kyo (Atomic Fuel Corp., Tokyo). Genshiryoku Kogyo, 11: No. 4, 27-32 (Apr. 1965). (In Japanese)

The large scale search for uranium in Japan was begun in 1954. Uranium bearing minerals were found in many areas, and the Ningyo Toge region was found most suitable for economic mining. The shallow deposits there are chiefly $Ca(UO_2)(PO_4)_2 \cdot nH_2O$ and the deeper deposits $CaU(PO_4)_2 \cdot nH_2O$. Uranium is leached from this ore with sulfuric acid (30 to 40 g/l) and a recovery of 80 to 90% is obtained. The uranium is removed from this leach by amine extraction. Succeeding refining steps followed by reduction to the metal are described. Uranium is fabricated in various physical states (metal, alloy, ceramic) and chemical forms (oxides, nitrides, carbides) for use as reactor fuel. Because reactor grade uranium is an expensive and potentially hazardous material, a rigid inspection program has to be maintained. A joint program was initiated with the USAEC to exchange information relating to uranium oxide and carbide type fuels. In anticipation of increased demand for uranium in the future, the separation and concentration of ^{235}U by gaseous centrifugation is being investigated. Test results with argon isotopes were encouraging. The problem of nuclear fuel reprocess-

ing is described briefly followed by a short account of the program for plutonium utilization. (TTT)

36551 SLOW PARTICLE DIFFUSION IN ION EXCHANGE COLUMNS. Cooper, Ralph S. (Los Alamos Scientific Lab., N. Mex.). Ind. Eng. Chem., Fundamentals, 4: 308-13(August 1965). (LA-DC-6731)

A general solution was derived for the behavior of an ion exchange column after the conditions of particle diffusion control and irreversible equilibrium. This solution includes time dependence, and does not rely on the usual "constant pattern" assumption. A number of diffusion models were examined, including the linear and quadratic forcing term approximations and the exact solution for diffusion into spheres. The quadratic approximation was found to be in close agreement with the exact solution. The exact solution was in the form of a double infinite series, which was slow to converge in certain cases, and a single series approximation was developed, which had more rapid convergence. (auth)

36552 KINETICS OF ION EXCHANGE IN MIXED SOLVENTS: Li^+-H^+ EXCHANGE IN METHANOL-WATER MEDIA ON AMBERLITE IR-120. Shankar, J.; Ghate, M. R. (Atomic Energy Establishment, Trombay, India.) Indian J. Chem., 3: 212-14(May 1965).

Kinetics of Li^+-H^+ exchange on Amberlite IR-120 resin in aqueous and methanol-water media were studied by shallow-bed techniques, in the lithium chloride concentration range from 0.001 to 0.1M. The data were analyzed by the film diffusion and particle diffusion equations. It was found that, below lithium chloride concentrations of 0.05M, film diffusion is the rate-controlling factor while at higher concentrations particle diffusion is rate-controlling. The results are discussed in terms of solution phase as well as resin phase characteristics in mixed solvents. (auth)

36553 DISTRIBUTION OF TRANSURANIUM ELEMENTS BETWEEN MAGNESIUM CHLORIDE AND ZINC–MAGNESIUM ALLOY. Knighton, J. B.; Steunenberg, R. K. (Argonne National Lab.). J. Inorg. Nucl. Chem., 27: 1457-62(July 1965).

Distribution coefficients of neptunium, plutonium, americium, curium, californium, and einsteinium between molten magnesium chloride and liquid zinc–magnesium were determined as a function of magnesium concentration in the metal phase. The measurements were made at 800°C except in the case of einsteinium, for which the temperature was 710°C. In general, neptunium, plutonium, and curium tended to favor the metal phase, whereas californium, einsteinium, and to a lesser extent, americium tended to favor the salt phase. The distribution coefficients indicated that certain transuranium elements could be separated from one another and from fission products by a sequence of liquid metal-molten salt equilibrations. This procedure had the potential advantages of relatively large separation factors and the use of solvents that resisted radiation damage. (auth)

36554 EXTRACTION OF SELECTED TRIVALENT LANTHANIDE AND ACTINIDE CATIONS BY BIS-(HEXOXY-ETHYL) PHOSPHORIC ACID. Peppard, D. F.; Mason, G. W.; Giffin, G. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 27: 1683-91(July 1965).

The extraction of Eu(III) and Am(III) from aqueous chloride and perchlorate media into benzene and cyclohexane solutions of $(n\text{-}C_6H_{13}OCH_2CH_2O)_2PO(OH)$, HDHoEP, was shown to be 2.5 power dependent on the formality of HDHoEP in the organic phase and inversely third-power dependent upon the concentration of hydrogen ion in the aqueous phase. The extracted entity, in the benzene system, is postulated as $M(Y)(HY_2)_2$, where $(HY)_2$ represents the dimer of HDHoEP, shown to be dimeric in dry benzene in the concentration range considered. In dry cyclohexane, HDHoEP was empirically trimeric and tetrameric, respectively, at 0.02F and 0.2F concentrations. The extractant was tentatively considered to exist as a mixture of trimers and tetramers in the wet cyclohexane of the system investigated. No attempt to formulate the extracted entity in Eu(III) and Am(III) extractions was made. Under comparable conditions, both Eu(III) and Am(III) were extracted by HDHoEP with distribution ratio, K, values approximately 500 times greater in cyclohexane than in benzene. (auth)

36555 RESIDUE ADSORPTION. II. SEPARATION OF BARIUM-140 AND LANTHANUM-140 BY REVERSE ORDER DESORPTION. Kirby, H. W. (Mound Lab., Miamisburg, Ohio). J. Inorg. Nucl. Chem., 27: 1701-11 (July 1965). (MLM-1243J)

The adsorption behavior of ^{140}Ba and ^{140}La was similar in aqueous solution to that of ^{90}Sr and ^{90}Y in that the ^{140}La was more strongly adsorbed than the ^{140}Ba. However, when the residue was washed with a non-polar solvent containing a small percentage of concentrated aqueous acid ^{140}Ba was more strongly adsorbed than ^{140}La. The results were interpreted on the basis of the ionic and complex characters of the barium and lanthanum compounds, respectively. Preliminary work indicated that the separation by residue adsorption of calcium from sodium, barium and strontium was feasible. (auth)

36556 THERMODYNAMIC QUANTITIES IN THE EXCHANGE OF LITHIUM WITH CESIUM ION ON CROSS-LINKED POLYMETHACRYLATE ION EXCHANGERS. Lindenbaum, S.; Boyd, G. E. (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 69: 2374-7(July 1965). (ORNL-P-1023)

Calorimetric measurements showed that heat was absorbed in the selective uptake of lithium ions from dilute aqueous solutions in an exchange reaction with cesium ions on cross-linked polymethacrylic acid (PMA) ion exchangers. The standard entropies of exchange, $\Delta S°$, observed with nominal 1 and 15% divinylbenzene cross-linked preparations were 1.8 and 6.2 eu, respectively. The magnitude of $T\Delta S°$ showed that it was the increase in entropy, which caused the standard free energy of exchange to be negative. The increase in $\Delta S°$ was attributed to a decrease in the hydration of Li^+ ions in the exchange reaction. It was proposed that the alkali metal cation affinity sequence $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$ for PMA exchangers resulted from "site-binding" of the lightest members. (auth)

36557 A THERMODYNAMIC CALCULATION OF THE IONIC STRENGTH DEPENDENCE OF ION-EXCHANGE REACTION SELECTIVITY COEFFICIENTS. Boyd, G. E.; Lindenbaum, S. (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 69: 2378-82(July 1965). (ORNL-P-1055)

Ion-exchange reaction selectivity coefficients for synthetic organic exchangers are known to be determined by the nature of the ionogenic groups, the exchange capacity, crosslinking, and the ionic composition of the copolymer. It was also required by thermodynamics that the ionic selectivity vary with the ionic strength, μ, of the external aqueous electrolyte if the swelling of the exchanger varies with μ and its ionic composition. Selectivity coefficients measured for the uptake of Br^- ion by the fluoride and chloride salt forms of a lightly cross-linked, strong-base anion exchanger showed increases of approximately 50 and 11%, respectively, when μ increased from 0 to 0.2 and 0.35 m. Thermodynamic calculations of the ionic strength dependence of the bromide-chloride selectivity coefficient were made based on the assumption that the exchanger was a three-component system. Satisfactory agreement with experiment was found up to $\mu = 0.2$; above this concentration, invasion of the exchanger by aqueous electrolyte occurred, and the assumption of a ternary mixture was invalidated. (auth)

36558 IODIDE METHOD OF ZIRCONIUM REFINING. Emel'yanov, V. S.; Evstyukhin, A. I.; Abanin, D. D. Met. i Metalloved. Chistykh Metal., Sb. Nauchn. Rabot, No. 4, 5-10(1963). (In Russian)

The mechanism of the transfer of nonmetallic impurities to the filament during iodide refining of zirconium, as well as the effect of degasification on this transfer was investigated, and a technique developed for producing highly purified Zr in a single-stage process. The iodide precipitation

of Zr was carried out in a Mo-glass refining vessel with Mo electrodes and a tungsten filament. Preliminary degasification was carried out in a quartz sidearm at 10^{-4}mm Hg and an optimal temperature of 850 to 950°C. Subsequent iodide refining was carried out at 300 to 320°C with a filament temperature of 1200 to 1300°C. The Zr obtained by this method was characterized by a marked reduction in the content of O_2 and H_2 (0.002 and 0.0004% by weight, respectively), to levels considerably below those attainable by three-fold refining using the older techniques; comparably low levels of N_2 and C (0.002 and 0.004%, resp.) were also obtained. The Zr bars obtained showed high plasticity (Brinell hardness of 40 to 45 kg/mm^2) and extremely high corrosion resistance. (CFSTI)

36559 SEPARATION OF ^{140}La FROM A ^{140}Ba–^{140}La MIXTURE BY CO-PRECIPITATION WITH FERRIC HYDROXIDE, USING SEVERAL ORGANIC BASES AS PRECIPITANTS. Koda, Yoshio; Takagi, Shigemichi (Nippon Synthetic Chemical Industry Co. Ltd. Japan). Radioisotopes (Tokyo), 14: 199-205(May 1965).

According to the standard method, the co-precipitation with ferric hydroxide in ammonium hydroxide (pK 4.72) was utilized for the separation of ^{140}La from a mixture of ^{140}Ba and ^{140}La. Almost all ^{140}Ba in the method without carriers and about 7% of ^{140}Ba in the method with carriers were precipitated with ferric hydroxide, Therefore, high-purity ^{140}La could not be obtained by this method. To separate pure ^{140}La from a ^{140}Ba–^{140}La mixture, several organic bases such as pyridine (pK 8.77), α-picoline (pK 7.52), benzylamine (pK 4.63), n-butylamine (pK 3.39) and ethylenediamine (pK 4.07) were also used as precipitants. By using these organic bases, it was possible to easily maintain a pH value of the test solution within a narrow range. When pyridine was used instead of ammonium hydroxide only 0.04 to 0.2% of ^{140}Ba was precipitated in the method without carriers. And, using α-picoline only 0.1 to 0.8% ^{140}Ba was precipitated. When benzylamine was used as a precipitant, the purity of ^{140}La was nearly equal in the case of ammonia water. The contamination of ^{140}Ba was inversely related to the degree of the pK value of the precipitants, that was the quantity of ^{140}Ba co-precipitated with ferric hydroxide increased in the concentration of OH^- ion in the solution. Although a similar result was obtained in the case of ^{90}Sr–^{90}Y, the purity of ^{140}La was lower than that of ^{90}Y. This may be because Ba^{2+} had a greater affinity for $Fe(OH)_3$ than Sr^{2+}. (auth)

36560 ON THE RADIOACTIVE DECONTAMINATION WITH SEVERAL KINDS OF SAND AND CLAY. Goto, Hidehiro; Suzuki, Shin; Inoue, Yasushi; Kudo, Reiko (Tohoku Univ., Japan). Radioisotopes (Tokyo), 14: 225-32 (May 1965).

From the standpoint of radioactive decontamination, the adsorptive properties of several kinds of sand and clay, occurring in various parts of Japan, were investigated by batch methods using fission products as adsorbates. The removal was different from sample to sample and ranged between 40 and 100%. The relation between the removal of fission products and chemical composition was not clear. All the samples rich in calcite adsorbed effectively and resembled each other in their adsorptive properties. The removal of rare earths was high, while the removal of ruthenium was low. In the case of strontium and cesium, decontamination was greatly affected by the nature of materials but there was little difference in the pH dependence between strontium and cesium regardless of materials. (auth)

36561 ADSORPTION STUDIES ON CLAY MINERALS: IX. ION-EXCHANGE PROPERTIES OF NATURAL AND THERMALLY ALTERED MONTMORILLONITE. Loven, Andrew W.; Thomas, Henry C. (Univ. of North Carolina, Chapel Hill). Soil Sci. Soc. Am. Proc., 29: 250-4(May-June 1965).

The ion exchange behavior of a thermally collapsed montmorillonite clay was compared with that of the natural mineral. Equilibrium measurements in the cesium-barium system at different temperatures demonstrated that the markedly increased selectivity for cesium, at low cesium content, shown by the altered clay was due to changes in the enthalpy of the exchange process partially compensated by a specific entropy effect favoring the sorption of barium. The standard free energies changed at 30°C on the natural and altered mineral (for the sorption of 2 moles of cesium) and were respectively, −3.38 and −3.19 kcal. These did not reflect the considerable increase in selectivity for cesium of the heated clay at low cesium content. Variation in the exchange capacity for barium of the heated clay when small amounts of cesium were present implied that this strongly sorbed ion renders many sites inaccessible to barium. (auth)

36562 INVESTIGATION OF THE ADSORPTION OF ANIONS ON ZIRCONIUM SURFACES. PART III. THE SEPARATION OF NUCLEAR ISOMERS OF ^{80}Br ON ZIRCONIUM SURFACES. Dreyer, R.; Dreyer, I. (Zentralinstitut fur Kernforschung, Deutsche Akademie der Wissenschaften, Berlin). Z. Physik. Chem. (Leipzig), 228: 177-83(1965). (In German).

The radionuclides ^{80m}Br, ^{80g}Br, and ^{82}Br, obtained by neutron irradiation of bromoform, were adsorbed, after separation from the initial products, from a 10^{-4} M sodium bromide solution on Zr samples in the form of bromide ions. The Zr samples were either newly prepared or exposed to air for various periods of time. After 200 min of soaking the activated samples in water, the radioactivities of the metal samples and that of the water were measured separately and the yields of the ^{80}Br isomeric separation were determined. For the 170-hr air-exposed Zr sample it was 55 to 60%, for the 60-sec exposed sample it was about 40%, and for the newly prepared sample it was only about 8%. On oxygen-coated Ni, a yield of 65% was found. The results are discussed in connection with the adsorption and desorption of bromide ions on differently treated Zr surfaces. (tr-auth)

36563 SELECTIVE FLUORINATION AND EXTRACTION OF BERYLLIUM-CONTAINING ORES. (to the Brush Beryllium Co.). British Patent 990,966. May 5, 1965. Priority date June 9, 1960, United States.

A process is patented for selectively extracting from Be-containing ores the Be content in the form of ammonium beryllium fluoride. Finely divided ore is reacted with an inorganic ammonium fluoride salt at a pressure of 200-700 psig and a temperature of 200-600°C. The mono-ammonium beryllium fluoride formed is extracted with water and reacted with sufficient ammonium fluoride to form normal ammonium beryllium fluoride. Yields of 92-99% of the Be in the ore are obtained. The silica is left substantially unreacted. (A.G.W.)

36564 METHOD FOR THE REMOVAL OF GASES FROM INTERSTITIAL POSITIONS IN TITANIUM, ZIRCONIUM, HAFNIUM, OR THORIUM. Rieck, Gerard Daniel; Bruning, Hugo Antoon Christiaan Maria (to N. V. Philips Gloeilampenfabrieken). German Patent 1,188,301. Mar. 4, 1965. Priority date Dec. 23, 1960, Holland.

The method of removing oxygen and/or nitrogen consists of establishing a temperature gradient of at least 50°C/centimenter in vacuo at temperatures above about 1000°C and of continuing this heat treatment until the gases have concentrated by diffusion in the portions at lower temperatures, whereupon these parts of the wires or strips of titanium, zirconium, hafnium or thorium are separated. (Gmelin Inst.)

36565 METHOD FOR THE EXTRACTION OF BERYLLIUM COMPOUNDS FROM AQUEOUS, BERYLLIUM-CONTAINING SOLUTIONS. Biermann, Wendell Joseph (to Beryloy Ltd.). German Patent 1,189,958. Apr. 1, 1965. Priority date June 4, 1962, United States.

The method comprises the steps of adding thiocyanate ions to the solution, of defining the pH value of the solution at 2 to 3, and of adding an organic oxygen-containing solvent with 4 to 10 carbon atoms. (Gmelin Inst.)

36566 METHOD OF CARBONATE LEACHING URANIUM ORES. Hillyer, John C. (to Phillips Petroleum

Co.). U. S. Patent 3,175,878. Mar. 30, 1965. Filed Feb. 24, 1960.

A process for leaching U values from a U-containing ore includes contacting the ore having a particle size of at least 25 mesh with a carbonate leach solution containing from 25 to 60 g/l of Na_2CO_3 and 2 to 20 g/l of $NaHCO_3$. The leaching mixture contains at least a portion of the values in the tetravalent state. The leaching mixture contains from 5 to 65% by weight of the ore admixed with cetylpyridinium bromide or fluorinated octanoate in an amount of 0.5 to 60 lb/T of ore to act as a surfactant in the leaching. Air is passed into the leaching mixture during the leaching process. The leaching solution is separated from the undissolved solids, and the U values may be recovered in any of the conventional manners. (B.L.M.)

36567 TREATMENT OF BY-PRODUCT URANIUM MATERIAL TO RECOVER PURIFIED CONCENTRATED URANIUM VALUES. Townend, Robert V.; Wilkalis, John E. (to Allied Chemical Corp.). U. S. Patent 3,175,879. Mar. 30, 1965. Filed July 8, 1960.

A process is reported for recovering U values from U waste materials containing a mixture of U oxides and V and Mo compounds as impurities. The waste solutions are reacted with a dilute sulfuric acid below 50% concentration, preferably 15–25%, in an amount in excess of that required to react with all the U in the waste. Sufficient MnO_2 is added to convert all the U(IV) to U(VI) at a temperature in the range of 50 to 140°C to form the soluble UO_2SO_4, and the insoluble materials are separated. Ferrous sulfate in an amount equal to at least two moles of ferrous sulfate per mole of UO_2SO_4 and an excess of HF are added to the solution at a temperature in the range of 20 to 100°C to precipitate the UF_4 hydrate and to form soluble ferric sulfate. The UF_4 hydrate is separated from the reaction mixture and dried under an atmosphere of gaseous HF at a temperature 100 to 200°C. The dried UF_4 hydrate is converted to anhydrous UF_4 by heating at a temperature of 300 to 600°C in an atmosphere of gaseous HF or in an atmosphere of an inert gas at a temperature of not more than 400°C. (B.L.M.)

36568 PROCESS FOR THE RECOVERY OF IRON AND URANIUM FROM SLAGS, BOILER WASTE AND THE LIKE. Johnson, Arthur F. (to Independence Foundation and Koppers Co., Inc.). U. S. Patent 3,175,900. Mar. 30, 1965. Filed June 18, 1958.

A metallurgical process is described for the treatment of lignites boiler waste, slages, and the like for the extraction of uranium and other heavy metals present in the form of an iron alloy. The lignites are burned to produce a molten silicate slag. The slag is reduced in a furnace, and aluminum and a sodium-lead alloy are added to produce an iron alloy containing substantially all the uranium or other heavy metals. (B.L.M.)

36569 LIQUID-LIQUID CONTACTING APPARATUS. Hebden, Donald; Hartley, Kenneth (to United Kingdom Atomic Energy Authority). U. S. Patent 3,192,019. June 29, 1965. Priority date Nov. 2, 1959, Great Britain.

A pulsed mixer-settler apparatus for the contacting of radioactive or otherwise dangerous liquids is provided with a contamination barrier between the pulsing system and the mixer tubes. The barrier consists essentially of a packed column through which a contaminant-absorbing liquid is passed continuously and unidirectionally. In the embodiment illustrated, water is sprayed into the column at the top and withdrawn from the sump connected to the bottom of the column. (A.G.W.)

36570 SEPARATION AND RECOVERY OF URANIUM FROM URANIUM–ALUMINUM ALLOYS. Gile, Herman S. (to U. S. Atomic Energy Commission). U. S. Patent 3,201,191. Aug. 17, 1965.

The process consists of dissolution in an aqueous solution of alkali metal hydroxide, nitrate, and nitrite followed by precipitation of uranium oxide by the addition of barium nitrate. (AEC)

36571 USE OF NICKEL ARSENIDES AND NICKEL TO PROMOTE PHASE SEPARATION IN LIQUID-LIQUID EXTRACTION. Collopy, T. J.; Mueller, J. H.; Miller, W. S. (to U. S. Atomic Energy Commission). U. S. Patent 3,202,476. Aug. 24, 1965.

A method is given for improving the separation of two liquid phases in a liquid-liquid extraction process. Finely divided Ni, NiAs, or $NiAs_2$ is added to a mixture of aqueous and organic phases to promote rapid coalescence of the two phases. (AEC)

36572 SEPARATION OF RUTHENIUM FROM AQUEOUS SOLUTIONS. Katz, Joseph J. (to U. S. Atomic Energy Commission). U. S. Patent 3,202,479. Aug. 24, 1965.

A process is given for volatilizing ruthenium in the form of ruthenium tetroxide from aqueous solutions by introducing ozone in the presence of a catalyst, such as permanganate, Ag^+, Ce(IV), and dichromate. (AEC)

ENGINEERING

General

36573 (ORNL-P-861) DEMOUNTING AND MACHINING IN HOT CELLS. King, E. M.; Dismuke, S. E. (Oak Ridge National Lab., Tenn.). Oct. 4, 1964. Contract W-7405-eng-26. 20p. (CONF-650601-1) Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Symposium on Working Methods in High-Activity Hot Labs., Paris.

The types of irradiation experiments which were disassembled and examined in the physical testing hot cells at ORNL are listed together with the tools used. Criteria for choosing tools are given. The ways in which the cutting equipment are used for disassembly are described using an ORR capsule, a fuel plate element, a poolside irradiation box, and a loop experiment as examples. (D.L.C.)

36574 (SC-TM-65-218) TRANSIENT BASE PRESSURE STUDY OF AN AXISYMMETRIC SUPERSONIC MISSILE FLYING HEAD-ON THROUGH A BLAST WAVE. Zumwalt, G. W.; Tang, H. H. (Oklahoma State Univ., Stillwater). May 1965. For Sandia Lab., Albuquerque, N. Mex. Contract AT(29-1)-789. 123p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

When a supersonic missile passes through a strong blast wave, such as that created by a nuclear explosion, the low pressure air trapped at the base of the missile acts as a cushion for the pressure rise. As the blast overpressure decays, a transient base pressure results which is an interaction of the instantaneous airstream conditions and the time-history of the jet mixing process at the base. The problem is thus divided into two parts: blast wave passage and post-passage-transients. The relation of base pressure versus time was sought by analytical means. For the first part of the problem, a flow model was devised for the conditions before and after the blast front passage over a slender axisymmetric missile. A solution was obtained by a transformation to a wave-attached coordinate system. For the transient conditions following the blast front, a quasisteady approach was adopted, using time iteration. To do so, it was necessary to extend Zumwalt's conical wake method for steady flow to include mass transfer from the airstream to the separate air at the base. A wind tunnel test program was designed and data analyzed to obtain empirical information required for effective conical jet pumping surface. These test included both steady-state and transient base pressures. An analysis resulted which is experimentally verified for simple base pressure transients and gives a prediction of base pressure-time history for head-on blast wave intersection with axisymmetric missiles. (auth)

36575 (TID-22025) EQUILIBRIUM CHARACTERISTICS OF AXIAL GROOVE GAS LUBRICATED BEARINGS. Lubrication Research Laboratory Report No. 1. Castelli, V.; Pirvics, J. (Columbia Univ., New York. School of Engineering and Applied Science). [1964]. Contract Nonr-266-(88). 72p. Dep. mn; CFSTI, $3.00 cy, $0.75 mn.

This report contains the description of a new general method for the solution of Reynolds equation for compressible and incompressible lubrication. A great improvement in numerical stability and speed of convergence is derived for all fluid film geometries including converging-diverging ones. The method is used for the determination of load coefficients and attitude angles of three- and four-pad axial groove cylindrical bearings. (auth)

36576 (TID-22073) SUSPENSION OF SOLIDS IN LIQUIDS IN CYLINDRICAL VESSELS BY MIXING IMPELLERS. Rushton, J. Henry; Fridley, Dale L. (Purdue Univ., Lafayette, Ind.). [1958]. Contract AT(11-1)-804. 30p. Dep.(mn); $2.00 cy, 1 (mn) CFSTI.

The conditions necessary to suspend various weight percents of three size ranges of spherical glass beads in water were studied in two sizes of tanks using various turbine impeller diameters and positions. The following correlation was derived: $P' = k\ T^{0.17}(T/D)^{-0.49}(d/D)^{0.87}\ W^{0.19}$, where P' = critical power, T = tank diameter, D = turbine diameter, d = average solid diameter, and W = weight percent solids. The suspensfon of mixtures of several solid size ranges was also studied; the critical power was found to be consistent, regardless of the proportions used. The effects of the solids on the power characteristics of the system were analyzed. (D.L.C.)

36577 (TID-22074) THE EFFECT OF PARTICLE SHAPE ON THE SUSPENSION OF SOLIDS IN REACTION VESSELS. Rushton, J. Henry; Tanksley, Robert N. (Purdue Univ., Lafayette, Ind.). [1961]. Contract AT(11-1)-804. 40p. Dep. (mn); $2.00 (cy), 1 (mn) CFSTI.

Analyses of variance show that in solid-liquid mixing the particle shape of the solid by itself as a factor has no significant effect upon the critical speed. However, the same results show that certain interactions of particle shape with impeller size, impeller height, and particle size, may have some significant effect upon the critical speed, although not to a great degree. From runs using irregular-shaped sand particles, the following correlation of mixing variables was developed: $N_c = 37.5\ D^{-1.53}\ C^{0.68}\ d^{0.35}\ W^{0.13} - 19$, where N_c = critical impeller speed, D = impeller diameter, C = distance between stirrer and bottom, d = particle diameter, and bottom, W = weight % solids. The correlation developed from the runs using spherical glass beads was $N_c = 57.2D^{-1.39}\ C^{0.63}\ d^{0.30}\ W^{0.14} - 18$. The slight disparity between these two correlations are caused by possible interaction effects of particle shape with other mixing variables upon the critical speed and by experimental error. The correlation developed from a composite of the sand and glass bead runs was $N_c = 45.9\ D^{-1.46}\ C^{0.65}\ d^{0.33}\ W^{0.13} - 15$. Measurements of settling velocities of particles in water showed that the size of a solid particle, but not its shape, has an important relationship to the particle settling velocity. This relationship, applicable in the particle size range of 55 to 460 microns, can be expressed as follows: for sand, $v = 10.1\ (10^{-3})\ d^{1.06}$; for glass spheres, $v = 8.8\ (10^{-3})\ d^{1.06}$; and composite, $v = 9.6\ (10^{-3})\ d^{1.06}$. When the above settling velocity–particle size relationships are coupled with the critical speed correlations, the settling velocity can be related to the critical speed by the following equations: for sand, $N_c = 170\ D^{-1.53}\ C^{0.68}\ v^{0.33}\ W^{0.13} - 19$; for glass beads, $N_c = 215\ D^{-1.39}\ C^{0.63}\ v^{0.28}\ W^{0.14} - 18$; composite, $N_c = 195\ D^{-1.46}\ C^{0.65}\ v^{0.31}\ W^{0.13} - 15$. (D.L.C.)

36578 (TID-22075) SUSPENSIONS OF SOLIDS IN LIQUIDS BY FAN TURBINE IMPELLERS. EFFECT OF SIZE, GEOMETRY, AND FLUID PROPERTIES. Rushton, J. Henry; Smith, Verne W. Jr. (Purdue Univ., Lafayette, Ind.). [1965]. Contract AT(11-1)-804. 38p. Dep.(mn); $2.00(cy), 1(mn).

The conditions required for suspension of various weight percents of three size ranges of glass beads in liquids of different densities and viscosities were studied in three sizes of tanks using three geometrically similar fan turbine impellers and three impeller positions. The effects these conditions had on the ability of the systems to suspend the solids were correlated as follows: $N_c = 65\ D^{-0.46}\ (T/D)^{0.25}\ (d/D)^{0.2}\ (C/D)^{0.5}\ W^{0.1}\ (\Delta\rho/\rho_L)^{0.3}\ \rho_L{}^{-0.3}\ \mu^{-0.02}$, where N_c is the impeller speed just necessary to lift all solids from the tank bottom, D is the impeller diameter, T is the tank diameter, d is the average solids diameter, C is the height of the impeller above the tank bottom, W is the weight percent solids, ρ_L is the density of the liquid, $\Delta\rho$ is the difference between solid and liquid densi-

ties, and μ is the liquid viscosity. The point of complete suspension was determined by a light transmittance technique. The constant K and the exponents were found to be constant values over the ranges studied. The effects of geometric changes in the system on the ability to suspend solids can be illustrated through a power per unit volume equation which is: $P_c/V = 0.05\ D^{0.65}\ (T/D)^{-2.25}\ (d/D)^{0.6}\ (C/D)^{1.5}\ W^{0.3}\ (\Delta\rho/\rho_L)^{0.9}\ \rho_L^{0.1}\ \mu^{-0.05}$. The power requirements for a fan turbine were compared with those of a flat-blade turbine for solid-liquid systems and found to be less in most cases. Also, a comparison of the power required for various impeller speeds with and without solids present in the system was made and no definite difference was found. (auth)

36579 (UCRL-13160(Pt.1)) TENSION WIRE SUPPORT STRUCTURES. FINAL REPORT: PART 1 OF 3. A PARAMETRIC STUDY OF TENSION WIRE SUPPORT FOR INSTRUMENTATION. Report No. MD-65-3. Frisch, J.; Steidel, R. F. Jr. (Lawrence Radiation Lab., Univ. of California, Berkeley). May 1965. Contract W-7405-eng-48. 68p. Dep.(mn), $3.00(cy), 2(mn) CFSTI

A study was made of tension wires as an alternative method of support for a sphere within an outer cylinder. The geometries of the wire-sphere support system are defined, and a sphere deflection theory was developed and verified experimentally with static loading. An odd number of wires is used for radial symmetry in the theory. The stress concentration at wire intersections can be reduced by padding. (D.L.C.)

36580 (UCRL-13160(Pt.2)) TENSION WIRE SUPPORT STRUCTURES. FINAL REPORT: PART 2 OF 3. ENERGY ABSORPTION IN A CYLINDRICAL SHELL UNDER TENSION WIRE LOADS. Report No. MD-65-3. Frisch, J.; Steidel, R. F. Jr. (Lawrence Radiation Lab., Univ. of California, Berkeley). May 1965. Contract W-7405-eng-48. 69p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

For a suspended package to withstand shock, means must be provided for absorbing kinetic energy. In the tension wire-sphere support structure studied in Part 1, little or no energy can be absorbed in the wires. The possibility of absorbing some of the kinetic energy as strain energy in the supporting (outer) cylindrical shell is studied. A relation between the edge loadings and the induced elastic strain energy is established, and an attempt is made to attach the supporting wires optimally for maximum storage of energy in the shell. (D.L.C.)

36581 (UCRL-13160(Pt.3)) TENSION WIRE SUPPORT STRUCTURES. FINAL REPORT: PART 3 OF 3. THE DESIGN AND STATIC TESTING OF THE FINAL ASSEMBLY. Report No. MD-65-3. Frisch, J.; Steidel, R. F. Jr. (Lawrence Radiation Lab., Univ. of California, Berkeley). May 1965. Contract W-7405-eng-48. 67p. Dep.(mn); $^.00(cy), 2(mn) CFSTI.

The wire size and number and wire attachment design in the tension wire-sphere support structure in an outer cylindrical shell were investigated. The information developed in this part and parts 1 and 2 was used to determine the specifications for a final assembly. This final assembly was tested. (D.L.C.)

36582 LIMIT ANALYSIS OF AXISYMMETRIC INTERSECTING SHELLS OF REVOLUTION. Ellyin, F.; Sherbourne, A. N. (Univ. of Waterloo, Ont.). Nucl. Struct. Eng., 2: 86-91(July 1965).

The general theory of the plastic analysis of axisymmetric shells of revolution is discussed and conditions for the construction of a complete solution and bounds to it are defined. It is shown that the various approaches to the collapse of the cylinder/sphere intersection may be placed in one of two categories. Approximate solutions, in conjunction with yield surfaces for cylindrical shells, are outlined. (auth)

36583 AN ELASTIC-PLASTIC ANALYSIS OF STRESSES AND STRAINS AT HYPERBOLIC NOTCHES IN FLAT PLATES. Tuba, I. S. (Westinghouse Research Labs., Pittsburgh). Nucl. Struct. Eng., 2: 92-101(July 1965).

An elastic-plastic solution is given for pure tension, pure bending, and pure shear at hyperbolic notches in flat plates. In order to illustrate the practicality of the formulation and method of solution three problems are illustrated, representing the three different types of loading conditions. (auth)

36584 CORROSION RESISTANT SEALING STRUCTURE. Rosen, Raphael (to U. S. Atomic Energy Commission). U. S. Patent 3,201,082. Aug. 17, 1965.

A valve sealing member is described which comprises an elastomer having incorporated therein a substantially completely fluorinated aliphatic compound composed chiefly of carbon and fluorine and containing no elements other than carbon, fluorine, chlorine and oxygen, more specifically rubber and polymerized trifluoromonochloroethylene, for use with fluorine or fluorine releasing compounds. (AEC)

Applications of Nuclear Explosions

36585 (NP-15107) A THEORY OF CRATERING FOR MULTIPLE NUCLEAR UNDERGROUND EXPLOSIONS. Final Report. Ash, James E.; Eichler, Thomas V. (IIT Research Inst., Chicago, Ill.). Apr. 29, 1964. Contract DA-44-009-AMC-661(T). 101p.

The crater sizes produced by underground explosions can be controlled by the use of simultaneously detonated multiple charges. A cratering theory is developed which relates the earth volume removal to the depth of burst and the horizontal separation distance between two buried nuclear explosions. The results are presented graphically in the form of parametric surface plots showing the scaled crater size dimension as a function of the scaled separation distance and scaled depth of burst for the pair of simultaneous explosions. The surface plot parameter is the total yield of the explosions. Quantitative theoretical results for single explosion yields of the order of 0.1 to 10 kilotons are based upon a free field analysis which approximates the relaxing expansion states of the shocked material by the Hugoniot graph and neglects the cavity growth. Verification of this theory is obtained from data for the single nuclear underground explosions Neptune (0.115 kt), Jangle U and Teapot Ess (both 1.2 kt). For larger explosions, such as Sedan (100 kt), a theoretical technique is developed which includes the cavity growth and the actual expansion state path of the shock-engulfed material. Quantitative theoretical results have been computed for two simultaneously detonated identical bursts. The results indicate that an enhancement in the total earth volume removal is attainable when a single explosive is divided into two individual equal explosives. Also, it is indicated that for any given depth of burial and total yield, an optimum separation distance exists for maximum enhancement. The effects upon the earth removal efficiency of nonsimultaneity have also been computed and compared with simultaneous explosions. (auth)

36586 (PNE-242F) THE SEDAN EVENT. Nordyke, M. D.; Williamson, M. M. (Corps of Engineers and Lawrence Radiation Lab., Univ. of California, Livermore). Apr. 1965. Contract W-7405-eng-48. 114p. Dep. mn.; CFSTI, $4.00 cy, $0.75 mn.

Project Sedan was a 100-kt nuclear cratering experiment conducted in 1962 to study cratering effects and the safety problems of such cratering detonations. Comparison of the crater dimensions with past experience shows that nuclear cratering explosions with optimum depth of burst result in craters with radii 10 to 20% smaller than equivalent-yield chemical explosions and with depths about the same. A dust cloud 50% larger than predicted was produced, and nearly five times more radioactivity than predicted came down in the local fallout. Close-in air blast measurements indicated peak overpressures four to five times larger than expected, but close-in air-blast impulses, impulse trans-

mission factors, and long-range air-blast signals were in agreement with predictions. Ground shock from Sedan fell well below the prediction functions; the earth motions were influenced by the Yucca fault. Mass distribution and ejecta studies were made which predicts the distribution for the 0.5-kt Scooter explosion within a factor of 1.5 to 2.0. Secondary craters were produced in the area around the Sedan crater. Observed surface motion agrees very well with predictions. (D.L.C.)

36587 (UCRL-12180(Rev.2)) AGGREGATE PRODUCTION WITH NUCLEAR EXPLOSIVES. Hansen, Spenst M.; Toman, John (Lawrence Radiation Lab., Univ. of California, Livermore). May 12, 1965. Contract W-7405-eng-48. 36p. Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

The application of underground nuclear explosions to break rock for the manufacture of crushed stone aggregate is considered. Data from several chemical and nuclear explosions in rock are given. Engineering considerations, costs, and safety considerations are discussed. It is concluded that this application is feasible. (D.L.C.)

36588 (UCRL-14197-T) ATOMIC ENERGY FOR MINING. Rabb, David D. (Lawrence Radiation Lab., Univ. of California, Livermore). [1964]. Contract W-7405-eng-48. 22p. (CONF-650535-1). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From 10th Annual Minerals Symposium, Grand Junction, Colo.

The possible applications of nuclear explosives in various areas of the mining industry are discussed. The advantages of, and experience with, nuclear explosives are described. Fission and fusion reactions are considered briefly. Costs of nuclear explosives are examined for several mining applications. (D.L.C.)

36589 (VUF-1022) PRESHOT AND POSTSHOT SAFETY SURVEY OF OIL AND GAS FACILITIES, BAXTERVILLE FIELD, MISSISSIPPI. Final Report. Ward, Don C. (Bureau of Mines, Bartlesville, Okla. Bartlesville Petroleum Research Center). Jan. 1965. PROJECT DRIBBLE—SALMON EVENT. 73p. Dep. mn; CFSTI, $3.00 cy, $0.75 mn.

Oil and gas wells and related facilities within a 5- to 10-mile radius of Ground Zero (Salmon Event) were examined and photographed pre- and post-shot. No postshot damage to any well or facility was found. The ground shock maximum was well below those values at which damage would be anticipated. (D.L.C.)

Facilities and Equipment

36590 (WAPD-T-1690) REMOTELY OPERABLE TOOLMAKER'S MICROSCOPE. Behr, L. M.; Eichenberg, J. D. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1965. Contract AT(11-1)-Gen-14. 9p. (CONF-651101-2). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

For Presentation at 13th Conference on Remote Systems Technology, Washington, D. C.

A toolmaker's microscope was adapted for remote use in a hot cell for measuring the distances between fiducial marks on irradiation samples. Closed-circuit television was used as the viewing method. Optimum conditions, accuracy, and operating experience are discussed. (D.L.C.)

36591 (Y-EA-37) SIGNIFICANT PARAMETERS OF CLEAN ROOM DESIGN. Choat, E. E.; Little, J. C. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 24, 1965. Contract W-7405-eng-26. 39p. (CONF-650533-1). Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

From American Assn., on Contamination Control, Annual Meeting, Miami, Fla.

A study is made of the following significant parameters for vertical laminar flow clean rooms: air flow, air distribution, filtration, protective clothing and limited access, and construction materials. The concept and design of the High-Purity Laboratory at Y-12 are reviewed, problems are examined, and performance data are reviewed. The air filtration system and testing methods are discussed in some detail. (D.L.C.)

36592 MODIFICATIONS TO THE CANBERRA HOMOPOLAR GENERATOR. Inall, E. K. (Australian National Univ., Canberra). At. Energy Australia, 8: 2-5(Apr. 1965).

The performance of Cu-C brushes to replace NaK jets in the homopolar generator and the bearing assemblies are discussed. The test results demonstrated that the generator can be used with solid brushes to provide large current pulses of various duty forms. Features of the brush design are described. (P.C.H.)

36593 REALIZATIONS OF BELGONUCLEAIRE IN THE FIELD OF LABORATORIES USING RADIOACTIVE COMPOUNDS. Draulans, J.; Nolet, G.; Baestle, L.; De Beukelaer, R. C. (BelgoNucleaire, Brussels). Atompraxis, 6: 314-20(June 1965). (In French)

The glove-boxes especially designed for the processing of plutonium in laboratories are described. A detailed description of the glove-box auxiliaries, i.e., the systems permitting control of their atmosphere, is also given. An irradiation cell with a 2000-C ^{137}Cs source for radiobiological experiments is described. The irradiation and lifting devices of the source as well as the different safety systems were developed. An experimental device for treatment of fission-product solutions by inorganic ion exchangers, in order to extract selectively the cesium and the strontium is described. (auth)

36594 ENVIRONMENTAL PROBLEMS IN EXTERNAL SPACE EQUIPMENT DESIGN. Alber, John D.; Imgram, Richard H. (Grumman Aircraft Engineering Corp.). IEEE (Inst. Elec. Electron. Engrs.), Spectrum, 2: 106-15 (July 1965).

A discussion is given of the environmental problems in external space equipment design. Temperature variation from near absolute zero to that of rocket exhaust can cause deformation of materials. The vacuum effects of space can cause sublimation and deformation of materials also. Radiation from the sun may be harmful to electronic components. The effect of meteoroids can cause erosion, which would bring about deterioration of thermal finishes or microwave radiation surfaces; also penetration might be an effect similar to firing small pellets into electronic gear. The design of a lunar excursion module antenna system is given in the light of these various space problems. (J.F.P.)

36595 RADIOISOTOPE GASES FOR SLUDGE DENSITY MEASUREMENT. PART I. GAGE CONFIGURATIONS AND APPLICATIONS. Cook, H. L. Jr. (Ohmart Corp., Cincinnati). Water Works Eng., 2: 88-9(June 1965).

Various possible arrangements of γ sources and detectors around pipes, for measuring sludge flow, are considered, as well as some applications of these various gage configurations. Gages of this type are successfully measuring a wide variety of products such as acids, alkalies, and slurries or sludges. A logical extension of the simplest configuration utilizes an expanded section of pipe to increase the path length of the γ radiation so that the percentage change in radiation field strength is increased for the desired change in specific gravity. Use of this expanded section requires careful analysis of the process material characteristics as well as the characteristics of radiation absorption. If a fairly viscous material is being measured, tunneling along the axis of the expanded section may occur. In addition, scattering of the radiation beam within the measured material may produce a percentage change in radiation field strength that is much less than might be expected as a result of the increase in path length. Although this configuration must be used with care, it has been successfully applied to the measurement of slurries whose solids are of relatively small particle size and fluids of relatively low viscosity, and where the existing pipe size is not large enough to permit the desired span. In the axial gage configuration the radiation path is along the axis of the pipe instead of across its diameter. Thus, the radiation path length is determined by the length of the straight section

of pipe rather than the diameter of the pipe. Typical accuracy for this configuration, using a 3-in. dia pipe, is 0.0005 sp gr or 0.05% of actual sp gr. Some problems in gage placement are also discussed. (BBB)

36596 HIGH SPEED ROTOR SYSTEMS. Linning, David Lees (to United Kingdom Atomic Energy Authority). British Patent 991,000. May 5, 1965. Filed Aug. 29, 1960.

A rotor system of elongated form can be operated at high speeds without problems due to whirling. Two concentric tubular rotors having differing critical speeds for development of whirling are connected for rotation at the same speed with an annular clearance between them such that at their critical speeds the rotors engage. Three embodiments of the system are described. (A.G.W.)

36597 IMPROVEMENTS RELATING TO HIGH PRESSURE VESSELS. Borsum, Finn; Jansson, Tage Valentin; Moberg, Carl Ake (to Aktiebolaget Atomenergi). British Patent 992,211. May 19, 1965. Filed Mar. 9, 1964.

A flanged joint for high-pressure vessels includes two flanges, two ring-shaped members engaging the flanges, and bolts for pressing the ring-shaped members and flanges against each other. Rollers are provided between the flanges and the ring-shaped members to allow a radial movement without friction between each flange and the ring-shaped member engaging the flange. (A.G.W.)

36598 COUPLING DEVICE. Leclou, Andre (to Commissariat a l'Energie Atomique). British Patent 994,599. June 10, 1965. Priority date July 24, 1962, France.

A coupling device is provided for the leak-tight mechanical connection of a pressure type vessel to an anchoring structure. The term anchoring structure includes any assembly to which an open vessel is intended to be attached. The vessel has an open mouth and a vertical axis of symmetry, and the anchoring structure includes a foundation block that carries a vessel base plate. The foundation block consists of a central portion that projects into the mouth of the vessel and a peripheral recessed portion that is secured to the vessel by an anchoring means. The base plate has a radially inner portion carried by the central portion and a radially outer portion projecting beyond the central portion and connected to the barrel. The anchoring means are integral with the vessel, are embedded in the foundation block, and have openings providing access to an annular chamber formed between the members and the central portion of the foundation block. (B.L.M.)

36599 METHOD OF DETERMINING THE LEAK RATES OF PRESSURE CONTAINERS. (to Licentia Patent-Verwaltungs-GmbH). British Patent 995,493. June 16, 1965. Priority date Mar. 23, 1961, Germany.

A method for measuring the leak rate of a pressure container consists of subjecting the container to an internal test pressure of between 0.1 and 0.15 atm above atmospheric pressure and measuring the internal pressure and temperature within the container during a certain test time. (B.L.M.)

36600 METHOD FOR OBTAINING SUFFICIENT TRANSPARENCY OF A GLASS PLATE EXPOSED TO RADIATION AND CLEAR, STABLE OBSERVATION WINDOWS BY USE OF THIS METHOD. Bonnet, Georges; Petit, Jean (to Commissariat a l'Energie Atomique). German Patent 1,188,740. Mar. 11, 1965. Priority date Sept. 3, 1959, France.

The glass plate of the window is rotatable about its horizontal middle plane. The thickness of the glass plate is chosen in such a way that the radiation is reduced at the vertical middle plane to a negligible intensity. (Gmelin Inst.)

36601 VIEWING WINDOW FOR A HIGH-ACTIVITY CELL. Bonnet, Georges; Petit, Jean (to Commissariat a l'Energie Atomique). German Patent 1,191,502. Apr. 22, 1965. Priority date Sept. 3, 1959, France.

The viewing window consists of a stack of fixed glass plates in the shielding of the hot cell and of two parallel, equal, and adjacent glass plates, which are shifted in front of the inner opening of the window in a plane parallel to the fixed glass plates. The two movable glass plates are shifted between two positions in such a way that while one of the two plates is in front of the stack the other one is retracted behind one of the two shields bordering the inside of the window. (Gmelin Inst.)

36602 AUTOMATIC SAMPLE CHANGER. Kingston, Peter F. (to Atomic Energy of Canada Ltd., Ottawa, Ont.). U. S. Patent 3,193,684. July 6, 1965. Filed July 21, 1961.

An apparatus for transporting a radioactive sample from a storage station to a counting station includes an elongated slide provided with an aperture for receiving a sample holder. Samples are stored in two axially aligned elongated chambers. The slide is located between the chambers and is normal to their longitudinal axis. Mechanisms are provided to transfer a sample from one storage chamber to the slide, to move the slide linearly to the counting station, to return the counted sample to the storage station, and to transfer it to the second storage chamber. The arrangement requires only a small opening in the lead castle used for counting, and the counting may take place at a considerable distance from the storage area. (A.G.W.)

Heat Transfer and Fluid Flow

See also PHYSICS — General.

Refer also to abstracts 38078, 38083, 38181, 38206, and 38244.

36603 (AEEW-R-281) A VISUAL STUDY OF FORCED CONVECTION BOILING. PART I. RESULTS FOR A FLAT VERTICAL HEATER. Kirby, G. J.; Staniforth, R.; Kinneir, J. H. (Atomic Energy Establishment, Winfrith (England)). Mar. 1965. 30p. Dep. mn; BIS, $0.90, HMSO, 4s. 6d.

Initial results are presented of a visual study of the hydrodynamics of boiling in channels and of burnout. It was found that the bubbles formed did not diffuse into the main stream at high heat fluxes, but remained close to the heater. Consequently severe coalescence took place, resulting in the formation of large regularly shaped bubbles. An analysis of the forces acting on these bubbles is given; this accounts qualitatively for the observed behavior. The above bubble formations result from the addition of heat at a wall so that clearly isothermal models, such as those using air–water mixtures, cannot give a true representation of the flow pattern. Attempts to view the heater surface at burnout were frustrated by poor visibility through the boiling mixture. (auth)

36604 (AEEW-R-304) SOME NUMERICAL RESULTS ON THEORETICAL MODELS FOR THE DYNAMICS OF A CROSS FLOW HEAT EXCHANGER. Hopkinson, A. (Atomic Energy Establishment, Winfrith (England)). Aug. 1963. 29p.

Cross flow and concentric tube counterflow models for the dynamics of a cross flow heat exchanger are studied numerically. The studies show: (1) that for the particular heat exchanger studied the temperature frequency responses of the two models are sufficiently similar to make it unnecessary to use the more complicated cross flow model; (2) the dependence of the frequency responses of the counterflow model on the primary to tube heat transfer; (3) the good agreement between the frequency response of the counterflow model and the frequency response corresponding to simple approximate transfer functions. The digital computer programs used in the studies are described. (auth)

36605 (AEEW-R-362) THE PREDICTION OF BURNOUT IN NON-UNIFORMLY HEATED ROD CLUSTERS FROM BURNOUT DATA FOR UNIFORMLY HEATED ROUND TUBES. Barnett, P. G. (Atomic Energy Establishment, Winfrith (England)). Nov. 1964. 67p. Dep. mn; BIS, $1.80, HMSO, 9s.

The practice of using burnout data for uniformly heated round tubes to predict burnout in non-uniformly heated reactor channels having complex cross sections is examined. At least two hypotheses are involved: (i) a relationship exists between uniform and non-uniform heat flux distributions and (ii) a relationship exists between simple and complex channel cross sections. Use of two such hypotheses, each accurate to ±15% and a correlation of uniformly heated round tube data having an rms error of 5%, could yield errors of ±40% in any predicted value; this figure of ±40% is regarded as a realistic upper limit for design purposes. It is shown that no method can exist for relating different channel cross sections to within ±15% and existing methods for relating different heat flux distributions incur some errors exceeding 20%. Furthermore, any suggested method for relating different heat flux distributions can be adequately checked only when a sufficiently large number of results are available and then the preferable alternative of correlating the data is possible. It is concluded that no reliable method can exist for predicting burnout in rod bundles from uniformly heated round tube data with sufficient accuracy for design purposes. (auth)

36606 (AEEW-R-430) AN EXPERIMENTAL INVESTIGATION INTO THE RELATIONSHIP BETWEEN BURN-OUT AND FILM FLOW-RATE IN A UNIFORMLY HEATED ROUND TUBE. Staniforth, R.; Stevens, G. F.; Wood, R. W. (Atomic Energy Establishment, Winfrith (England)). Mar. 1965. 26p. Dep.; BIS, $0.80; HMSO, 4s.

Previous work on forced convection burn-out with Freon 12 at 155 psia produced data so similar to data for water at 1000 psi that it was reasonable to suppose that the same mechanism of burn-out applied to both fluids. Further work with Freon 12 is presented in which the flow rate of liquid along the inner wall of a heated round tube is measured at various flux levels up to burn-out. The evidence is consistent with a simple picture of burn-out in which the liquid film on the wall evaporates until it becomes so thin as to effectively disappear. The film thickness is influenced by entrainment and by deposition of liquid from the core, but it is not possible at present to distinguish between these effects. There is an abundance of liquid present in the channel other than the liquid on the wall, indicating potential in artifically reinforcing the liquid film and so increasing the burn-out heat flux. (auth)

36607 (INR-588/IX/R) ZAGADNIENIA CIEPLNE I PRZEPLYWY W KONWEKCYJNEJ PETLI SODOWEJ. (The Experimental Investigations of Liquid Sodium Heat Transfer and Fluid Flow in the Laboratory Convection Loop). Kaminski, Fr. (Institute of Nuclear Research, Warsaw (Poland)). Dec. 1964. 26p. Dep.

A discussion is given of the experimental investigation of the heat transfer from the vertical pipe to liquid sodium in the case of natural convection and the calibration of the magnetic flowmeter for the small volume rates of sodium. The results of the measurements of the heat losses from the vertical unisolated pipes are also presented. These heat losses are considered as a function of the average temperature of sodium flowing inside. The results of investigations were compared to the results of similar experiments of various authors. (auth)

36608 (IS-1137) PREDICTION OF PEAK HEAT FLUX IN BOILING HEAT TRANSFER. Breen, Bernard P.; Burnet, George (Ames Lab., Iowa State Univ. of Science and Tech.). Apr. 21, 1965. Contract W-7405-eng-42. 26p. (CONF-650905-1) Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

For Presentation at American Institute of Chemical Engineers Symposia, Minneapolis.

Single wire thermocouples spot welded to the surface of a steam-heated, polished, horizontal, stainless-steel tube produced characteristic signals during nucleate and transition boiling of acetone. A point of strong discontinuity in measured boiling surface temperature was evident when a given thermocouple site went from nucleate into transition boiling. A unique method was developed for promoting early transition at a thermocouple site by implanting at the site a small slug of high thermal conductivity material. The signal from the thermocouple at this site could then be used to predict the approach to peak heat flux. (auth)

36609 (NAA-SR-11123) HYDRAULIC STUDIES OF THE LSGR PROCESS CHANNEL. Brindley, J. H. (Atomics International, Canoga Park, Calif.). June 15, 1965. Contract AT(11-1)-Gen-8. 47p. Dep.(mn); $2.00 (cy), 1(mn) CFSTI.

Hydraulic tests were performed with water on a full-scale mockup of the Large Sodium Graphite Reactor (LSGR) process channel consisting of a process tube containing an 18-rod cluster of fuel rods, "cookie cutter" spacers at 1-ft intervals, and a variable-orifice assembly. Reported are pressure-loss flow-rate characteristics of entrance and exit components; fuel rod spacers; the fuel bundle; and a unique variable flow-control device. Principles of dimensional similitude were used to convert water test data to those of LSGR coolant conditions. The sodium flow rate through the process channel at the design core pressure drop of 21.0 psi can be controlled from 45.5 to 13.4 lb/sec with the variable orifice. Radial velocity-profile studies in the fuel bundle demonstrated that V(max)/V(avg) = 1.33. Fuel-rod-spacer drag coefficients, based on de Stordeur's correlation, were found to be constant at 1.5 over a Reynolds number range of 1,000 to 20,000. (auth)

36610 (NASA-TN-D-2924) HEAT-TRANSFER AND PRESSURE DROP CORRELATIONS FOR HYDROGEN AND NITROGEN FLOWING THROUGH TUNGSTEN WIRE MESH AT TEMPERATURES TO 5200 DEG R. Siegel, Byron L.; Maag, William L.; Slaby, Jack G.; Mattson, William F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). July 1965. 28p. CFSTI, $2.00 cy.

Correlations for variable property heat-transfer and friction pressure drop data were obtained for forced convection of hydrogen and nitrogen through electrically heated tungsten wire mesh. These correlations represent the data of six different helically coiled wire meshes for the following range of conditions: mesh porosity of 64 to 72.2 percent, wire diameter of 0.020 to 0.035 inch, surface temperature of 1400 to 5200°R, outlet gas temperature of 600 to 2400°R, mass velocity for hydrogen of 0.4 to 3.1 lb/sec-ft^2 and for nitrogen of 4.5 to 10.2 lb/sec-ft^2, heat flux of 0.5 to 8.3 Btu/sec-in.^{2}, and pressure level of 1 atmosphere. The effect of flow bypass, resulting from a mesh heater not filling the flow passage, was investigated on a 0.030-inch-diameter wire mesh for a bypass area of 25 percent. (auth)

36611 (NP-15121) SOME ANALYTICAL ASPECTS OF BUBBLE DYNAMICS. Report No. 85-30. Hsieh, Din-Yu (California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science). Apr. 1965. 58p.

A unified, systematic survey of the recent developments of bubble dynamics is presented with the emphasis on its analytical aspects. A general formulation of the problem is established first; then it is shown how simplifications may result from the spherical symmetry of the system and the assumption of uniform interior of the bubble. Two classes of problems of physical interest are treated subsequently; namely, the growth and collapse of a bubble, and the bubble in oscillation. In the first category, various aspects of the problem are investigated depending on whether the inertial, the thermal, or the diffusive effect is the dominating controlling factor of the motion. In the second category, the non-linear mechanical oscillations are discussed, as well as the linear oscillations with thermal and diffusive interactions. A study of the stability of the spherical symmetry of the flow system is included. (auth)

36612 (ORNL-3807, pp 189-217) EXPERIMENTAL INVESTIGATIONS OF HEAT TRANSFER AND FLUID FLOW. Hoffman, H. W. (Oak Ridge National Lab., Tenn.).

The experimental investigation of flow phenomena in beds

of 1½-in.-dia. graphite spheres randomly packed in a full-scale reactor core model was concluded with the study of two additional beds in a number of configurations. Measured void fractions agreed with values obtained with previous beds. No relationship was found between either the average angle of repose or the variation in the angle of repose around the bed with bed-loading conditions. Average radial velocity profiles were obtained for beds with and without fill cones and for beds of various depth. The results showed maximum velocities near the core wall and minimum velocities at the core axis; oscillations in the velocity intermediate to these extremes are ascribed to the random nature of the bed packing and, specifically, to the strong influence of the void distribution at the bed exit face. The variation in local velocities with angular position at any radial location showed no clear trend for flat-topped beds. In contrast, for beds with fill cones, the local velocity showed an increasing angular variation with increasing distance from the vessel wall and suggested significant radial flows. Total radial diffusivities were measured by injecting a He trace flow into the mainstream air flow at various positions around the bottom of the bed and sampling the flow at a number of points above the bed and along the vessel wall. The ratio of the average diffusivity to the mean superficial velocity (E/V_m) was of the order of 0.15 and the Peclet modulus based on this diffusivity was approximately 10. The experimental data on mass-transfer rates from spheres in randomly packed beds show a normal distribution about the mean value with a standard deviation of ±4.5%; for regular-array beds, this deviation is reduced to ±3.2%. Data on local mass-transfer coefficients in ordered arrays at two levels of the Schmidt modulus for several values of the particle Reynolds modulus were obtained. Measurements of the local voidage distribution in random sphere beds were made with the use of a radiographic technique. The results for the overall segmental void fraction gave a value of 0.377 ± 0.033. A statistical analysis of the point void fraction data indicates that these values vary randomly in the bed. (auth)

36613 (WAPD-T-1652) STABILITY ANALYSIS FOR A STEAM GENERATOR (thesis). Pulick, Michael A. (Pittsburgh Univ., Pa.). 1965. Contract AT(11-1)-Gen-14. 77p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A digital-computer analysis designed to predict the presence of oscillations in downcomer flow, steam flow, or water level for a steam generator is presented. In addition, the analysis solves for the steady-state internal conditions—downcomer flow, pressure drops, and enthalpies throughout the steam generator. The analysis is based on linearizing the transient conservation equations. Linear feedback control theory is used to develop an open loop transfer function from the resulting linearized equations. The stability of the open loop transfer function, which represents the stability of a small perturbation about a steady-state operating condition, is examined by a Nyquist stability criterion. Results from a sample test problem indicate excellent agreement between predictions of the analysis and experiment. (auth)

36614 (WCAP-5449) FORCED-CONVECTION HEAT TRANSFER TO WATER AT NEAR-CRITICAL TEMPERATURES AND SUPERCRITICAL PRESSURES. Bishop, A. A.; Sandberg, R. O.; Tong, L. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). [1964]. Contract AT(30-1)-2948. 29p. (CONF-650603-1). Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

From Joint Meeting of the American Institute of Chemical Engineers and the British Institution of Chemical Engineers, London.

Heat transfer film coefficients were determined experimentally for forced convection flow of supercritical water in circular tubes. The tests covered the following range of operating parameters: inside tube diameter 0.1–0.2 in., pressure 3300–4000 psia, mass flow rate $0.5–2.7 \times 10^6$ lb/hr-ft^2, heat flux $0.1–1.7 \times 10^6$ Btu/hr-ft^2, coolant temperature 650–1000°F, and wall temperature 721–1231°F. Film coefficients increased with increasing mass flow rate and decreased with increasing heat flux throughout the entire pressure-temperature region investigated. Below the pseudo critical temperature the temperature at which the heat capacity at constant pressure reaches a maximum, film coefficients decreased with increasing pressure, and increased with increasing pressure above the pseudo critical temperature. Under certain conditions where the heat flux exceeded approximately 0.85×10^6 Btu/hr-ft^2, audible sound was generated within the test section. At heat fluxes in the range of 1.0×10^6 Btu/hr-ft^2, surface temperature excursions were observed when the outlet fluid temperature was near the pseudo critical temperature. A correlation of the experimental heat transfer results was obtained based on dimensionless groups, which predicted experimental Nusselt numbers within ±15%. Comparison of data of previous investigators with the correlation showed good agreement. (auth)

36615 DEPOSITS FORMED BENEATH BUBBLES DURING NUCLEATE BOILING OF RADIOACTIVE CALCIUM SULFATE SOLUTIONS. Hospeti, Narayan B.; Mesler, Russell B. (Univ. of Kansas, Lawrence). A.I.Ch.E. (Am. Inst. Chem. Engrs.) J., 11: 662-5(July 1965).

Previously microlayer evaporation beneath a bubble was postulated to explain the sudden temperature drops observed during nucleate boiling of water. A method was devised to estimate the microlayer thickness from the deposit formed by a series of bubbles during nucleate boiling of saturated calcium sulfate solution containing radioactive sulfur-35. The results support the microlayer evaporation hypothesis. (auth)

36616 CRITICAL THERMAL LOAD IN BUNDLES WITH SPACER LATTICE. Kon'kov, A. S.; Barulin, Yu. D. At. Energ. (USSR), 18: 640-2(June 1965).

Critical thermal load in bundles with a spacer lattice was determined, and the effect of the spacer devices on the magnitude of critical thermal load was investigated. The experiments were carried out with seven rod fuel bundle with external longitudinal flow of water-steam mixture 98.1 bar pressure, 600 kg/m^2 · sec mass velocity, and steam content up to 13% in a direct flow and closed circulation loops. The experimental data using two types of spacer lattices operating in a direct-flow and closed schemes showed that the magnitude of critical thermal load in closed loop was higher than in direct flow. Published data on thermal load as a function of steam-content were compared. The comparison of magnitudes for critical thermal loads for the bundles with coolant flow over and for water-steam mixture flow through pipes showed that the critical thermal load for external bundle cooling was lower than in pipes. (R.V.J.)

36617 THE EFFECT OF A PROJECTION ON HEAT TRANSFER IN A COOLANT CHANNEL. Lawther, K. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, Sydney). Australian J. Appl. Sci., 15: 215-26(Dec. 1964).

The effect of an annular projection on heat transfer in an annular channel was investigated for gas flows at Reynolds numbers in the range from 100,000 to 275,000. Variations in surface heat transfer are represented by effective Stanton number profiles. Considerable local improvements in heat transfer were obtained, with significant local variations in gas and surface temperatures near the projection. (auth)

36618 THE EFFECT OF A PROJECTION ON PRESSURE LOSSES IN CHANNEL FLOW. Lawther, K. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, Sydney). Australian J. Appl. Sci., 15: 227-41(Dec. 1964).

The effect of discrete annular projections on the flow in an annular channel at Reynolds numbers in the range from 75,000 to 300,000 is discussed. Data are given on the pressure loss associated with these projections, and the axial variation in static pressure at the channel wall. The pressure loss data were correlated by a relation that includes factors for projection height, projection thickness, and spacing between projections. (auth)

36619 A STUDY OF THERMAL TRANSPIRATION USING ULTRAHIGH-VACUUM TECHNIQUES. Edmonds, T.;

Hobson, J. P. (National Research Council, Ottawa). J. Vacuum Sci. Technol., 2: 182-97(July-Aug. 1965).

The thermal transpiration ratio $R = P_1/P_2$ was measured by the absolute method in helium and neon over the pressure range $10^{-3} \leq P_2 \leq 60$ torr. Cold temperatures were $T_1 = 77.4$ and 232°K with warm temperature $T_2 = 295$°K. An aperture and various tubes were used at the temperature interface. For the aperture $R_m = (T_1/T_2)^{1/2}$ was found, as expected, at low pressures but this value was not found, in general, for tubes. The latter case represents a departure from normal assumptions, which are examined in detail. A related conclusion is that the relative method for measuring R is unreliable for tubes at low pressures. It is concluded that a molecule has a greater probability of traversing a tube from the hot end to the cold end than in the opposite direction. It is found that several analytic expressions for R represent the data satisfactorily after suitable choice of constants. (auth)

36620 TWO-PHASE PRESSURE GRADIENTS IN THE APPROACH REGION TO CRITICAL FLOW. Nahavandi, Amir N.; Von Hollen, Richard F. (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 22: 463-9(1965).

An analytical model for the prediction of steam-water critical-flow pressure, mass discharge and pressure gradients in the approach region to critical flow is presented. The continuity, momentum and energy equations are applied to successive differential elements along the conduit and are solved numerically on an IBM-7094 digital computer for the maximum discharge flow rate. The proposed model assumes thermal equilibrium conditions and employs the modified Armand correlation to relate the void fraction to steam quality. The frictional losses in the momentum equation are obtained by two methods: a separated flow model and Armand model. A comparison of the analytical predictions with available test results on small diameter pipes shows that: the present model agrees with the published test data; and both frictional loss models are equally valid, and the selection of a particular method depends on the degree of conservatism desired. (auth)

36621 FORCED-CONVECTION BOILING BURNOUT FOR WATER IN UNIFORMLY HEATED TUBULAR TEST SECTIONS. Griffel, Jack; Bonilla, Charles F. (Columbia Univ., New York). Nucl. Struct. Eng., 2: 1-35(July 1965).

To thoroughly study the effects of the major variables in forced-convective burnout, 402 high-pressure critical heat flux determinations were made with seven uniformly heated, internally-cooled, tubular test sections using water, subcooled at the inlet, as the coolant. Data were collected over the following range of variables: critical heat flux, 0.44 to 2.57×10^6 Btu/hr-ft^2; mass velocity, 0.5 to 13.7×10^6 lb/hr-ft^2; exit coolant conditions, 116.6°F subcooled to 59.2% quality; pressure, 500 to 1500 psia; heated length, 24 to 77⅞ in.; and inside diameter, 0.245 to 1.475 in. The 1.475 in. tube represents the largest tube ever tested. The results indicated the existence of three burnout regimes: nucleate boiling, annular flow, and the "transition" region. An analytical study of annular flow burnout based on observations and dimensional analysis yielded a correlation, which related the critical heat flux to the significant local fluid properties and flow parameters. This equation was used to correlate and study the critical heat flux data obtained together with a selection of additional data points from the major available sources, including data for freon-12. The equation contains four dimensionless groups and constants determined by regression analysis with a limited portion of the data. Critical heat fluxes calculated by the correlation were in good agreement with the measured values. Observations of the effects of the parameters in subcooled nucleate boiling burnout enabled the formulation of an empirical equation for this regime. The equation related the critical heat flux only to the mass flow rate and subcooling. In testing the equation with available data it was found that the correlation holds throughout the 60 to 2000 psia pressure range equally well, thus implying that there is no pressure effect on subcooled burnout over this entire range. (auth)

36622 TWO-PHASE FLOW DATA FOR NON-CIRCULATING AND SLOWLY CIRCULATING MIXTURES. Smissaert, George E. (Pennsylvania State Univ., University Park). Nucl. Struct. Eng., 2: 36-9(July 1965).

Slip ratios are presented for air-water, nitrogen-mercury and nitrogen-freon-113 mixtures flowing at superficial liquid velocities up to one foot per second. For non-circulating mixtures, the void fraction is presented as a function of the superficial gas velocity in air-water and in nitrogen-mercury. (auth)

36623 RESEARCH ON HEAT AND MASS TRANSFER. Anastasijevic, Predrag; Afgan, Naim. Nukl. Energija, 1: No. 2, 8-12(Feb. 1965). (In Slovenian)

Investigations of the problems of gas-cooled reactors were carried out on the basic problems of heat transfer intensification from gas cooled surfaces, and on the measurement of thermal and aerodynamic characteristics of gas-cooled reactor fuel elements. Heat transfer intensification was studied under both positive and negative pressure gradients. Heat transfer from corrugated and extended surfaces is also studied. Two-phase flow is another aspect of heat transfer studied. Burnout, thermal contact resistance, and work on liquid metals are included also in these investigations. The organization and long-term plans are mentioned. (auth)

36624 PROBLEM OF COMPRESSED GAS FLOW INTO HOMOGENEOUS MAGNETIC FIELD. Lobanova, L. F. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 6, 31-8(Nov.-Dec. 1964). (In Russian).

The problem of the influence of end effects on the spreading of flow during the flow of a compressed gas into a homogeneous magnetic field concentrated in the electrode region of a plane channel is considered. The variation of average (according to channel cross section) flow characteristics along the channel is studied in the approximation of small magnetic Reynolds number and small MHD interaction parameter. The effects of the Mach number, the limiting value of electric field potential, and the ratio of electrode length to channel width on the average flow characteristics are investigated. (tr-auth)

36625 PROCEEDINGS OF THE 1965 HEAT TRANSFER AND FLUID MECHANICS INSTITUTE HELD AT LOS ANGELES, CALIFORNIA, JUNE 21, 22, 23, 1965. Charwat, Andrew F. (ed.). Stanford, California, Stanford University Press, 1965. 378p. $10.00. (CONF-650618).

Proceedings of the June 1965 meeting of the Heat Transfer and Fluid Mechanics Institute are presented. Nineteen papers were presented on: boundary-layer flows, including mass transfer and non-equilibrium effects; free shear flows and separated regions; radiation heat transfer and radiation gas dynamics; low-density flows, non-Newtonian fluids, and phase-change phenomena; and plasma flows and arc facilities. (M.C.G.)

36626 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGE TUBES. Reising, George Frederick Stanley (to Babcock and Wilcox Ltd.). British Patent 989,343. Apr. 14, 1965. Filed Jan. 10, 1961.

A heat exchange tube formed of steel and of approximately oval cross section has wall parts of relatively large and substantially constant radii of curvature that merge into wall parts of small radii of curvature. This cross sectional shape may be obtained by subjecting a circular tube to a cold drawing operation between suitably arranged dies. The tube wall parts of relatively large radii of curvature are provided with transverse fins that are adapted to reinforce the wall parts while the parts of relatively small radii are free of external reinforcement. The fins are joined to the walls by flash or resistance welding, are all shaped with inner edges curved to fit the wall parts, and the outer edges are parallel to the inner edges. All fins are bevelled at both faces so that the faces of the fins converge at the side edges. The fins alternate long and short lengths with each long fin composed of three aligned parts and each short fin composed of two aligned parts united at the wall part. (B.L.M.)

36627 IMPROVEMENTS IN AND RELATING TO TUBULAR HEAT EXCHANGERS. (to Maschinenfabrik Augsburg-Nurnberg AG). British Patent 991,030. May 5, 1965. Priority date Apr. 28, 1961, Germany.

A tubular heat exchanger is designed for heat-carrying media having a high melting point. Fluid displacing elements formed as electrically heatable bars are inserted into primary tubes through which a heat-carrying medium passes so as to form an annular space for fluid flow. The primary tubes are surrounded by secondary tubes through which a heat-removing medium passes. The heatable displacing bodies constitute an auxiliary source of heat to prevent the heat-carrying medium from falling below the melting point and solidifying when the operation is being started or stopped or is interrupted. (A.G.W.)

36628 HEAT EXCHANGER. Amorosi, Alfred; Morabito, John J. (to Atomic Power Development Associates, Inc.). U. S. Patent Re. 25,808. Reissued June 22, 1965. Filed Apr. 29, 1964.

A heat exchanger for use with two liquids that, if brought into contact, would generate high pressures within the heat exchanger is provided with a pressure-relief system. The exchanger consists essentially of a tank through which liquid sodium is circulated and a series of heat exchange tube assemblies extending downward into the body of liquid sodium. Water and steam generated from it are circulated through the tubes out of contact with the sodium. An inert-gas space is provided above the liquid sodium within the tank to provide a surge chamber, and an outlet leading from the space is closed by a frangible diaphragm designed to break at pressures in excess of the normal pressure in the space. Reaction products of water and sodium can thus be carried from the tank in the event of a break in a heat exchange tube. (A.G.W.)

36629 CELL STRUCTURE FOR HEAT EXCHANGER. Maillet, Ennemond (Commissariat a l'Energie Atomique). U. S. Patent 3,179,573. Apr. 20, 1965. Priority date Feb. 8, 1962, France.

A tubular element cell for a heat exchanger is made up of an external liner divided into two portions of substantially the same length by an intermediate partition extending at right angles to the cell axis and intermediate between the cell ends. Each of the two portions include at least one inlet duct for a cooling fluid in the liquid phase and a number of tubular elements for vaporizing the fluid. The tubular elements are disposed symmetrically at spaced intervals about the axis of the cell, and the inlet duct and vaporization elements are connected in the vicinity of the intermediate partition by means of radial ducts. These radial ducts have a nozzle-like tapered configuration adapted on the one hand to throttle the liquid phase and on the other hand to form a liquid film on the inner wall of the vaporization elements. The film flows in the axial direction with a helical motion along the walls of the elements. (B.L.M.)

Materials Testing

Refer also to abstract 36535.

36630 (CONF-650517-1) BASIC PRINCIPLES OF NONDESTRUCTIVE TESTING. [Holt, Robert C.] (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 27, 1965. Contract W-31-109-eng-52. 8p. Dep.(mn).

From American Society of Quality Control, Albany Section, Latham, N. Y.

The validity of nondestructive testing methods must be evaluated by direct, destructive methods. Sometimes the nondestructive methods are found to be insensitive to the expected defects and sensitive to unexpected defects. The following methods and the causes of such anomalies in these methods are discussed: liquid penetrant inspection, x radiography, and ultrasonics. (D.L.C.)

36631 RADIOISOTOPES, THE USE OF RADIATIONS—SPECIAL EQUIPMENT FOR THE GAMMAGRAPHIC INSPECTION OF CABLE BUTT WELDS. Microtechnic, 19: 106(Apr. 1965).

A brief description is given of a special rotary positioner intended for the gamma-graphic inspection on cable-laying ships of end-to-end welds of submarine cables. This inspection consists of taking six pictures of each weld, the radioactive source moving in steps of 60° along a circular path in a plane at right angles with the cable axis, with a distance of ~700 mm between the source and the film. The instrument is provided with circular guide-ways in which a barrel rotates. The latter carries an arm at the extremity of which is fixed the container with the radioactive source which rotates around the cable. The same movement causes the rotation of a film slide arranged opposite to the source with respect to the cable. With this arrangement, photographs are taken in steps of 60° each in identical operating conditions. The radiation source is brought into the working position by mechanical remote controls and it supplies a γ beam automatically directed towards the cable and the film. Because of very rigid construction, troublesome vibrations are excluded. The equipment can be fixed on the cable, a certain length of which has already been rolled up. It can be installed either as a fixed station or on a carriage. (BBB)

Protective Structures

36632 (AD-608531) SIMULATION OF THE RESPONSE OF EQUIPMENT LOCATED IN UNDERGROUND INSTALLATIONS TO BLAST INDUCED GROUND MOTIONS. Report No. 102. (Barry Research and Development, Watertown, Mass.). Nov. 30, 1964. Contract DA-49-146-XZ-108. 180p. (DASA-1549). CFSTI, $5.00.

The characteristics of the response of isolated equipment installed in underground structures to the ground motions induced by nuclear blast are defined in terms of weapon yield, distance from blast, ground conditions, and natural frequency of equipment suspension. A design approach is proposed for a variable stiffness, multi-degree-of-freedom device capable of generating the isolated equipment response motions. Pneumatic double-acting cylinders and elastomer springs are selected as the variable stiffness mechanism. Pneumatic rams are selected as the displacement mechanism. The performance characteristics of a model built using the proposed design approach are defined by means of acceleration-time traces of the motions generated for different values of oscillating frequency, load, and initial displacement. Conclusions and recommendations are made based on comparison of the motions generated by the model to the expected response motion of isolated equipment in underground installations. (auth)

Space Propulsion

See also REACTOR TECHNOLOGY — Propulsion and Space.

Refer also to abstract 37728.

36633 (AD-608206) INTENTIONAL COMBUSTION OSCILLATIONS IN PROPULSION SYSTEMS. Scientific Report No. 1. Swithenbank, J.; Harris, D. (Sheffield Univ. (England). Dept. of Fuel Technology and Chemical Engineering). June 1964. 65p. (SR-1; AFOSR-64-2029; HIC-45). CFSTI, $3.00 cy, $0.75 mn.

The object of this research program is to determine useful applications of oscillatory combustion. In particular the generation of MHD power is suggested by the high ionization obtained in a combustion wave. In the limit, a detonation wave releases all the energy of combustion in the 'oscillation' and maximum temperatures are obtained. If the wave is a travelling tangential mode, theoretical studies suggest

that either strong isentropic waves or cyclic detonation waves may be formed. Calculations of the MHD power generation by such waves is presented. (CFSTI)

36634 (LA-DC-7224) HEAT TRANSFER IN MISSILES AND SPACE OPERATIONS. Boyer, Keith (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1965]. Contract W-7405-eng-36. 21p. (CONF-650611-2) Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Symposium on Heat Flow Below 100 deg K andits Technological Applications, Grenoble, France.

A brief review is presented of heat transfer studies of propulsion system problems at cryogenic temperatures. These problems include storage of liquid hydrogen, forced convection heat transfer to liquid hydrogen, transient heat flow, and system dynamics. (D.L.C.)

36635 (N64-26583) MAGNETOGASDYNAMIC ROCKET FOR SPACE PROPULSION. Summary Report. Sunderland, R. J. (MHD Research, Inc., Newport Beach, Calif.); Asam, A. R. (Marquardt Corp., Van Nuys, Calif.). May 20, 1964. Contract NAS 3-2514. 93p. (NASA-CR-54040; MR-25118). CFSTI, $8.60 cy.

A linear crossed field plasma accelerator and test facility was developed. Thrust measurements performed with the accelerator at gas flow rates of 0.1 g/sec of argon were inaccurate and nonreproducible because of erosion of the accelerator electrode insulators. Severe material erosion limited continuous operation of the accelerator at magnetic fields above 500 gauss to a few minutes. Hall deflection was successfully reduced by staggering the accelerator electrodes. (auth)

36636 (N64-29222) DEVELOPMENT OF A COAXIAL PLASMA GUN FOR SPACE PROPULSION. Gooding, Terence J.; Hayworth, Bruce R.; Larson, Alan V.; Ashby, David E. T. F. (General Dynamics/Astronautics, San Diego, Calif.). June 1964. Contract NAS 3-2594. 67p. (NASA-CR-54149). CFSTI, $6.60 cy.

A description is given of the work done in an experimental program to evaluate the pulsed coaxial plasma gun as a thrustor for space propulsion applications. The pursuit of efficiency led to the development of a low-loss, lightweight energy storage capacitor, which exhibits pulse line behavior. An energy inventory shows that the plasma resistive losses are small and that the accelerator efficiency is not limited by poor energy transfer from the energy source to the plasma. The thermal efficiency (exhaust energy-stored energy) was increased to 45% at an average exhaust velocity of about 7 cm/μsec. A theoretical discussion shows that a significantly higher efficiency can not be expected with the present mode of operation, but that two other modes are available that in principle have no such limitation. (auth)

36637 (NP-15148) COLD NUCLEAR POWER FOR SPACE FLIGHT. Carroll, Robert L. [nd]. 130p.

The analysis indicates that a new type of nuclear reaction occurs at a temperature of absolute zero. This reaction is a disruption process which releases particle energy, but absorbs thermal energy, and can be made self-sustaining and confined within the solid walls of a reaction chamber. Application of the reaction to rocket propulsion results in a specific impulse of 4×10^6 at least, with any thrust level that can be tolerated by the structure. A static thrust of 100 tons can be generated by the use of less than 3 pounds per minute of the reacting material. A 100 ton rocket can be accelerated to the escape velocity of 7 miles per second by the use of less than 60 pounds of the reacting material. The reaction products are of such a nature that the protection of personnel does not seem to be a major problem. The electronic heat pump providing the temperature necessary to instigate the reaction is described. (auth)

36638 SIMULATION OF ROCKET-NOZZLE ENVIRONMENTS WITH AN ARC-PLASMA GENERATOR. Flood, D. T.; Schaefer, J. W. (Itek Corp., Palo Alto, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 1361-3(July 1965).

The development and use of an arc-plasma generator as a rocket simulator are discussed. A description of the arc-plasma generator, the requirements for accomplishing simulation of the chemically reactive rocket environment, and some typical test results are presented briefly. A 1-Mw(e), magnetically stabilized, d-c arc-plasma generator was used to provide the appropriate high-temperature, chemically reactive environment. Both solid- and liquid-propellant rocket environment simulation were accomplished using the arc-plasma generator. The results indicate the capability and advantages of the arc-plasma generator for simulation of the rocket nozzle environment. The tests included a definite investigation of the effects of chemical reaction and mechanical shear on material performance in addition to the investigation and development of the arc-plasma generator for rocket environment simulation. (J.F.P.)

36639 PROSPECTS FOR ELECTRIC PROPULSION IN SPACE. Edgecombe, Donald S. Battelle Tech. Rev., 14: No. 7, 17-21(July 1965).

Because of their high amount of thrust developed for each pound per second of propellant flow, electric engines are promising for use on deep-space probes. The present chemical rockets cannot deliver such high payloads within a reasonable time for deep space missions. There are three main types of electric engines, which are described, these are the ion engines, plasma engines, and thermal jet engines. There are also engines combining the main features of these three types. Of all the types of electric engines proposed, four will be completely developed. These four are described. They are the contact-ionization ion engines, the electron-bombardment ion engines, the thermal arc jets, and the arc plasma jets. (J.F.P.)

36640 AUTOMATIC CONTROL SYSTEMS FOR ION ENGINES. Worlock, R. M.; Forrester, A. T.; Purmal, G. W.; Schneider, A. M.; Sohl, G. (Electro-Optical Systems, Inc., Pasadena, Calif.). J. Spacecraft Rockets, 2: 280-1(Mar.-Apr. 1965).

The operation of automatic control systems for two types of ion engines (contact and electron bombardment engines) is outlined. The contact engine control system performs the following tasks: upon command, starts up the engine and brings it to a predetermined level of operation; maintains thrust at a predetermined level and controls ionizer temperature according to a criterion which is described; and upon command shuts down the engine. The start-up sequence is described. The electron bombardment engine control system performs the following tasks: upon command, starts up the engine and brings it to a predetermined level of operation; maintains thrust at a predetermined level; maintains discharge chamber current at a value linearly related to the ion beam current; upon command shuts down the engine. The start-up sequence, which is described, for the bombardment engine is more complicated than for the contact engine; for each, the procedure is basically one of bringing engine components to operating temperature. The control system illustrated was tested with the engine and feed system. All cycles were completely automatic, the only operator action being the initiation of each start-up and shutdown. (TCO)

36641 MATERIAL DESIGN CONCEPTS FOR UNCOOLED NUCLEAR ROCKET NOZZLES. Locke, S. R.; Ahearn, R. L. (Martin Co., Denver, Colo. and Orlando, Fla.). pp 287-310 of Materials Science Research. Vol. 2. New York, Plenum Press, 1965.

An uncooled nuclear rocket nozzle would provide significant weight, cost, and reliability advantages. Current data on materials indicated that composite materials systems would be capable of successful operation in the extreme environments imposed on nuclear rocket nozzles. A four-basic-composite-materials-systems concept is presented. (auth)

36642 RECENT ADVANCES IN ELECTROTHERMAL AND HYBRID ELECTROTHERMAL-ELECTROMAGNETIC PROPULSION. John, Richard R.; Bennett, Stewart (Avco Corp., Wilmington, Mass.). 33p. (CONF-650416-5). ORINS.

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif.

Recent experimental and analytical results on the performance and practical application of electrothermal and electromagnetic space propulsion engines are presented. The engines considered are the resistojet, the electrothermal arc jet, and the hybrid electrothermal-electromagnetic arc jet. The high-specific-impulse thermo-ionic accelerator, the current plasma accelerator, the magnetic annular plasma accelerator, the Harcjet, the magnetohydrodynamic arc thruster, and the magnetoplasmadynamic arc jet are hybrid arc jets. In the resistojet and conventional arc jet electrical energy is transferred to thermal energy by passage of the working fluid over a solid heating element or arc discharge. The thermal energy is in turn converted into kinetic energy by expansion of the working fluid through a conventional nozzle. In the hybrid arc jet the gas flow is accelerated both by aerodynamic forces and by electromagnetic forces due to the interaction of the ionized gas flow with self-induced and externally applied magnetic fields. The spectrum of specific impulse covered by these neutral-plasma devices range from a few hundred seconds to over 10,000 seconds. This makes it possible to carry out a variety of missions. (J.F.P.)

36643 COLLOID PROPULSION; STATE OF THE ART AND REVIEW OF CURRENT RESEARCH. Hendricks, Charles D. (Univ. of Illinois, Urbana). 15p. (CONF-650416-4). ORINS

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif.

Making the assumption that electric propulsion works and is eventually useful, then the possible utility of colloid propulsion is examined in the light of that assumption. A general discussion of the characteristics of beams to be used, and the techniques of producing these beams is given. It is concluded that the best methods of colloid propulsion are electric spraying, capillary; electric spraying, rotating cup; and condensation, charging. (J.F.P.)

36644 NUCLEAR VEHICLE TECHNOLOGY. Steele, A. J. (Lockheed Aircraft Corp., Sunnyvale, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint AIAA Paper No. 65-589, 34p. $1.00. (CONF-650610-9). ORINS

From American Inst. of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs.

The principal contributors to inert weight are seen to be the structures, propellant conservation, and engine subsystems. Structures and propellant conservation are discussed. For these there is a discussion of the present state of the art, project trends into the future, and an estimate of when these technologies will be ready for flight vehicle application. Then the technology costs are compared with cost savings that can be made. Finally the findings are summarized and on-orbit technologies are mentioned. It is concluded that significant gains can be achieved in the structures and propellant conservation subsystem areas for nuclear vehicles requiring modest cryogenic storage on orbit. (J.F.P.)

36645 ON ALFVEN WAVE PROPULSION. Gross, R. A. (Columbia Univ., New York). 6p. (CONF-650416-7). ORINS

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif.

The generation of Alfven waves by electrically conducting satellites is discussed as a possible engineering consideration. It is suggested that instead of producing a drag on a satellite, an Alfven wave might be used as a propulsion mechanism, if a source of electric power in the satellite is used to reverse the current flow. The cause of these waves is explained, their possible effects on satellite propulsion is discussed; and it is suggested that they be investigated further. (J.F.P.)

Vacuum Engineering

36646 PHOTOTUBE PROCESSING USING PORTABLE DIODE AND TRIODE SPUTTER-ION PUMP VACUUM SYSTEMS. Theodorou, D. G.; McIntosh, R. O. (Bendix Corp., Southfield, Mich.). J. Vacuum Sci. Technol., 2: 208-9(July-Aug. 1965).

Photomultipliers, image intensifiers, and television camera tubes are processed using simple, portable, ultra-high vacuum systems. These systems use relatively small sputter-ion pumps, both diode and triode, which are simple in operation, clean, and portable. The processing system is described especially the use of the sputter-ion pumps. It is noted that the pumps must be operated at low pressures in order to extend their lives. Also to improve starting characteristics and maintain nominal speed the pumps must be periodically baked in a vacuum furnace. (J.F.P.)

36647 AN ATTEMPT TO REDUCE THE GAS LOAD IN AN ULTRAHIGH-VACUUM CHAMBER. Adler, Joel E. M. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Vacuum Sci. Technol., 2: 209-10(July-Aug. 1965).

The Ilikon ultra-high vacuum chamber is described. This chamber is used to study the physical properties of the lunar surface materials by simulating the lunar conditions such as temperature, pressure, and radiation. Emphasis is placed on the vacuum and sealing of the flanges. The properties of various types of O-rings, used for sealing, are discussed. Also methods for the reduction of contaminants on chamber walls, to decrease the gas load and increase the efficiency of the pumpdown, are noted together with their effectiveness. (J.F.P.)

GEOLOGY AND MINERALOGY

General

Refer also to abstracts 36313 and 36315.

36648 SOME ASPECTS OF THE GEOCHEMISTRY OF YTTRIUM AND THE LANTHANIDES. Fleischer, Michael (Geological Survey, Washington, D. C.). Geochim. Cosmochim. Acta, 29: 755-72(July 1965).

Recent data on the relative abundances of the lanthanides and yttrium in meteorites, basaltic rocks, granitic rocks, and sedimentary rocks are reviewed. It is shown that the data were inadequate to substantiate or to disprove Taylor's derivation from these data of a 1:1 abundance ratio of basaltic to granitic rocks in the continental crust. Graphs are given to illustrate the variation of lanthanides in minerals with paragenesis. Both the paragenesis and the crystal chemistry of minerals affected the composition of the lanthanides. (auth)

Natural Radioactivity and Fallout

See also HEALTH AND SAFETY.

Refer also to abstracts 35889, 35892, and 35945.

36649 (AD-614997) FALLOUT STUDIES—CLOUD CHEMISTRY. Final Report. Norman, J. H.; Winchell, P.; Bell, W. E.; Reidinger, A. B. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Jan. 29, 1965. Contract OCD-PS-64-222. 62p. (GA-6094). CFSTI, $3.00 cy.

The measured absorptions per atmosphere between 1260 and 1400°C of Cs, Ru, Sb, Te, and Mo in $CaO-Al_2O_3-SiO_2$ samples with varying SiO_2 content are, respectively, 10^3 to 10^5, 10, 10^4, 10^9, and 10^5 to 10^4 times the ideal values as calculated by Miller. These measurements were made by equilibrating fission-product-containing oxygen with the various silicates at the experimental temperature. When cesium was used in this type of experiment, some anomalous behavior was noted. Attention is called to the effect of gaseous ions on chemistry occurring during fallout formation. Diffusivities of Cs, Sb, Te, and Mo are reported as determined in diffusion-limited evaporation studies and plane-source-technique studies. Values of measured diffusivities are such as to suggest that condensed-state diffusion of the moderately volatile fission products should be important in fallout formation. Variation of diffusivity of Sb with silicate composition was studied. Mass-spectrometric studies of the thermodynamics of vaporization of the alkaline earth oxides are reported. Gaseous species whose thermodynamic properties are reported were found to include M, MO, M_2O, and M_2O_2 species. Microprobe studies of fallout particles revealed concentration gradients for many elements in fallout particles. These studies clearly portrayed accretion events occurring in the first few seconds after a nuclear event. A discussion is presented of the importance of thermodynamic properties of fission products and silicates and the kinetics associated with the fission-product absorption process, with particular emphasis on condensed-state diffusion and particle accretion events. (auth)

36650 (AEET-208) MEASUREMENTS OF AIRBORNE RADIOACTIVE FALLOUT IN INDIA. Rangarajan, C.; Gopalakrishnan, Sarada; Sadasivan, S.; Chitale, P. V. (Atomic Energy Establishment, Trombay (India)). 1965. 27p. Dep. mn.

Airborne radioactivity measurements at eight sampling stations in India are reported for the period 1957 to 1964. The measurements included gross β activity and ratios of the isotopes ^{137}Cs, ^{95}Zr, ^{140}Ba, ^{125}Sb, ^{106}Ru, and ^{54}Mn. Some rain water radioactivity data are also given. (D.L.C.)

36651 (COO-1199-6) RADIOACTIVE RAINOUT RELATIONS IN CONVECTIVE RAINSTORMS. Research Report 1. Huff, Floyd A. (Illinois State Water Survey, Urbana). Mar. 1965. Contract AT(11-1)-1199. 135p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Results are presented for case studies of 7 convective storms in 1963. Detailed data are presented on the time and space distribution of radioactive rainout from these storms. Radiochemical analysis of samples of precipitation provided data on the concentrations of gross β, ^{90}Sr, and ^{144}Ce. Radar and raingage data were used to evaluate the effects of developmental stage of convective cells and location of cells with respect to sampling stations with respect to sampling stations on the concentration of radioactive rainout. It was concluded that cell developmental stage and station location with respect to rain-producing cells are a partial cause of the large spatial and temporal variability in rainout concentration observed in convective rainstorms. Factors affecting the complex relation between radioactive rainout and meteorological conditions are discussed. (C.H.)

36652 (NYO-3364-3) CESIUM BODY BURDEN AND ITS VARIATION IN 22 NORWEGIAN SCHOOL BOYS. (Norsk Radiumhospital, Oslo). [1964]. Contract AT-(30-1)-3364. 16p. Dep.(mn), $1.00(cy), 1(mn) CFSTI.

The content of ^{137}Cs and K were determined by whole-body counting in 22 Oslo school boys, aged 16, 17, or 18, in March 1963, Oct. 1963, March 1964, and Oct. 1964. The content of ^{137}Cs in all subjects increased from March to Oct. 1963, but only a slight increase was observed in 11 subjects from Oct. 1963 to March 1964. From March 1964 to Oct. 1964, 15 showed an increase in ^{137}Cs content and 7 showed a decrease. Data on the height and weight of the subjects are included. The relation of ^{137}Cs content to the global distribution of fallout from nuclear weapon tests is discussed briefly. (C.H.)

36653 (NYO-3364-5) CESIUM-137 IN MILK IN NORWAY 1962–1965. Madshus, Kjell (Norsk Hydro's Inst. for Cancer Research, Oslo); Stroemme, Aksel (Norsk Radiumhospital, Oslo); Koren, Kristian (Statens Radiologisk-Fysiske Laboratorium, Oslo (Norway)). Contract AT(30-1)-3364. 42p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Data are presented on the ^{137}Cs content in milk samples collected in Norway from 1962 to 1965. Seasonal variations based on monthly observations are reported. (C.H.)

36654 DETERMINATION OF THE RATIO BETWEEN THE CONCENTRATION OF THE RADIONUCLIDES Ce^{144} AND Cs^{137} IN SOLID ATMOSPHERIC PRECIPITATIONS. Voljin, V. Acad. Rep. Populare Romine, Studii Cercetari Fiz., 15: 55-9(1964).

An attempt was made to identify and determine the concentrations of the radionuclides ^{144}Ce and ^{137}Cs in solid atmospheric precipitations that fell in Bucharest between December 25, 1962 and February 12, 1963; the ratio between these concentrations was found to give some indications as to the age of these radionuclide mixtures in the air. The preparation and the analysis of snow samples are described, the results obtained are discussed, and the value of the ratio $^{144}Ce/^{137}Cs$ was established. It is pointed out that although the amount of precipitations sensibly varied during the sampling period, the ratio $^{144}Ce/^{137}Cs$ remained practically constant, showing only a slight decrease towards the end of the interval. (Rumanian Sci. Abstr., Nat. Sci., Vol. I, No. 6, 1964)

36655 FISSION PRODUCT CONCENTRATION IN THE CHUKCHI SEA. Bowen, Vaughan T. (Woods Hole Oceanographic Institution, Woods Hole, Mass.); Sugihara, Thomas T. Arctic, 17: 198-203(Sept. 1964).

The changing fallout concentrations in the Chukchi Sea from 1959 to 1962 fully confirm the flow patterns inferred from temperature-salinity data, only if the source waters are assumed to have exhibited ^{90}Sr concentrations within

the ranges reported for the northwestern Pacific by Miyake and by Higano. Study of the ^{90}Sr concentrations in the Arctic Ocean may be expected to help to clarify the patterns and rates of circulation in this difficult area. (TCO)

36656 GAMMA-RAY SPECTROMETER STUDIES OF HYDROTHERMALLY ALTERED ROCKS. Moxham, R. M. (U. S. Geological Survey, Washington, D. C.); Foote, R. S.; Bunker, C. M. Econ. Geol., 60: 653-70(June-July 1965).

The uranium, thorium, and potassium contents of hydrothermally altered rocks in the vicinity of several copper and copper-lead-zinc deposits in Arizona were determined by chemical analysis. Potassium in the more intensely altered zones was about twice that in unaltered areas. There is no corresponding increase in thorium, so a higher potassium/thorium ratio also resulted from alteration; abnormally high uranium, locally in secular disequilibrium, was observed at the Bagdad porphyry copper deposit. A truck-mounted gamma spectrometer was used to obtain a spectrum of gamma emission at each sample location. Equating the spectrometric with the chemical data gave standard errors of 0.6% potassium, 3 ppm thorium, and 10 ppm uranium for the outcrop analyses with the spectrometer. The amount of potassium introduced by hydrothermal alteration was thought to be sufficient in quantity to be detected by either surface or aerial spectrometry; spectrometric detection of anomalous uranium is probably marginal, owing to the disequilibrium. The potassium/thorium ratio may provide a means of distinguishing, in such surveys, between hydrothermally altered high-potassium zones and unaltered extrinsically high-potassium intrusives. (auth)

36657 SULFUR ISOTOPES OF SOME CENTRAL AFRICAN SULFIDE DEPOSITS. Dechow, E.; Jensen, M. L. Econ. Geol., 60: 894-941(Aug. 1965).

About 550 sulfides and 10 sulfates were isotopically analyzed from sulfide deposits situated in Northern and Southern Rhodesia and in the Katanga Province of the Republic of the Congo. The sulfide deposits in an acid intrusive belt each had a mean $\delta^{34}S$ value close to +5‰ which is the same as the $\delta^{34}S$ value for sulfides disseminated in acid intrusive bodies. These intrusive bodies presumably formed as the result of granitization during the latest phase of metamorphism. The deposits associated with Basement domes showed average $\delta^{34}S$ values increasing with metamorphic rank from +3.8‰ in the Solwezi dome to +12.8‰ in the Kabompo dome, but the sulfides in overlying sediments differed considerably in the total spread of $\delta^{34}S$ values and were more suggestive of containing biogenic sulfur. A quartz monzonite body near the Kabompo dome exhibited $\delta^{34}S$ values of +11.3‰ and +13.4‰. One deposit (Mujimbeji), in shear zones, contained lighter sulfur that may have been derived from pre-existing biogenic sulfur through preferential mobilization of ^{32}S into the shear zones, and another deposit (Kanasanshi) that occurred in discordant quartz carbonate veins consisted of stratified sulfides that may have been derived through mobilization during later metamorphism. The deposits in the Lufilian arc area may be classified in three groups. First, discordant Pb–Zn and Cu deposits enriched in ^{32}S that have been emplaced during an early stage of metamorphism and associated granitization. Second, stratified copper deposits, possibly containing sulfur of biogenic origin. They are located on the flanks of a mantled gneiss dome along a metamorphic front where isotopic exchange reactions or differential mobilization of ^{32}S and ^{34}S may have occurred that modified the original $\delta^{34}S$ values and resulted in an enrichment of ^{32}S with increasing distance from the Basement unconformity. Third, late Pb–Zn–Cu deposits and discordant Cu deposits that are enriched in ^{34}S on the inner margins of the Lufilian arc. Sulfides in gabbros, that are really scapolitized amphibolites, varied in $\delta^{34}S$ values from +1.0‰ to +15.7‰. The gabbros are intrusive into the Upper Roan dolomites. The isotopic analyses were fairly consistent with $\delta^{34}S$ values of sulfides occurring in the Basement domes but did differ from hydrothermal deposits in the Basement rocks of Southern Rhodesia. (P.C.H.)

36658 INVESTIGATION OF THE PRIMARY Sr^{87}/Sr^{86} RATIO IN DIFFERENTLY METAMORPHOSED ROCKS OF THE NORTHERN BAIKAL-FORELAND WITH THE PURPOSE OF ABSOLUTE AGE DETERMINATION. Yashchenko, M. L.; Warshavskaya, E. S.; Manuilova, M. M. (Lab. of Precambrian Geology, Leningrad). Geokhimiya, No. 5, 528-33(May 1965). (In Russian)

A study was made of the primary isotopic $^{87}Sr/^{86}Sr$ ratio in effusives of the Akitkansk series of the Middle Proterozoic (Pt_2), which to different degrees were influenced by metamorphic processes. Unaltered effusives had a primary isotopic ratio of $^{87}Sr/^{86}Sr = 0.705 \pm 0.001$ and an age according to the Rb-Sr method of 1710 ± 35 million years. The data obtained were compared with the earlier made determinations of the primary isotopic ratio $^{87}Sr/^{86}Sr = 0.803 \pm 0.023$ for granites of the Abchad intrusion of the Irelsk complex (Pt_2) and for gneisses (metavulcanites), which were metamorphized under conditions of an amphibolitic (on its boundary with a granulitic) facies, accompanied by processes of a metamorphic differentiation and of anatexis. It is shown that processes of a high-temperature metamorphism, accompanied by a metamorphic differentiation and anatexis, cause a shift in the primary isotopic ratio. (auth)

36659 URANIUM AND THORIUM IN MAGMATIC ROCKS OF THE KUZNETSK BASIN. Osipov, D. K.; Zhuravliof, R. S. (Inst. of Geology and Geophysics, Academy of Sciences, Siberian SSR). Geokhimiya, No. 5, 619-24(May 1965). (In Russian)

The distribution of U and Th in the most recent magmatic rocks of the Kuznetsk Basin and its eastern boundary was examined by means of a microradiographic method. It was found that, in contradiction to the behavior of acid intrusive rocks, the formations examined contained relatively uniformly distributed U and Th. The Upper-Paleozoic dolerite–monzonite and monzonite–essexite rocks contained an average of 3.77×10^{-4}% U and 13.4×10^{-4}% Th at a Th/U ratio of 3.6; in the Lower Mesozoic basalts the U and Th concentrations were found to vary from 2.66 to 3.13×10^{-4}% and 9.43 to 13.20×10^{-4}%, respectively, yielding Th/U ratios between 3.6 to 4.2. In the dolerite–monzonite and monzonite–essexite rocks the U + Th was usually bound to the felspars; in the basalts these elements were mostly concentrated in a vitreous mass. A direct linear correlation could be established between U and Th and between these two elements and the SiO_2, K_2O and MgO contents of the rocks. In the trap rocks, the U and Th probably fill in the interstices and other lattice defects. (TTT)

36660 ON THE AGE OF UNDERGROUND WATER NEAR VOLGOGRAD IN VOLGA REGION. Mitrofanov, V. Z. (Scientific-Research Inst. of Petroleum and Gas Industry, Volgograd, USSR). Geokhimiya, No. 5, 624-7 (May 1965). (In Russian)

The method based on determination of the He and Ar content of gases dissolved in underground waters or found in the free state was used for determining the age of the water table on the basis of the formula $T = He/Ar\ 115 \times 10^6$ years. The results obtained were not very accurate because average values were assumed to prevail for the porosity, radioactivity of the minerals, and the diffusion of the gases; the presence of radiogenic Ar formed by the decay of ^{40}K was not taken into account. The mass-spectrographic method based on direct determination of ^4He and ^{40}Ar in natural gas was used together with the above formula for determining the age of underground water tables in anthracitic and Devonian deposits in the Don-Medvedits area, the Tarsin depression, and the Privolzh monoclinal in the Volga region. The results indicated that the anthracitic and Devonian formations are saturated with waters formed during the Tertiary period. (TTT)

36661 RELEASE AND MOVEMENT OF RADIONUCLIDES IN SOILS CONTAMINATED WITH FALLOUT MATERIAL FROM AN UNDERGROUND THERMONUCLEAR DETONATION. Essington, E. H.; Nishita, H.; Steen, A. J. (Univ. of Calif., Los Angeles). Health Phys., 11: 689-98 (Aug. 1965).

Fallout material from an underground thermonuclear detonation was analyzed to determine the presence of several longer lived radionuclides. The following radionuclides were identified: $^{95}Zr-^{95}Nb$, ^{103}Ru, $^{106}Ru-^{106}Rh$, ^{131}I, $^{137}Cs-^{137}Ba$, $^{140}Ba-^{140}La$, ^{141}Ce, $^{144}Ce-^{144}Pr$, ^{46}Sc, ^{54}Mn, ^{89}Y, ^{102}Rh, ^{181}W, ^{185}W and $^{188}W-^{188}Re$. Radiotungsten contributed the major fraction of the total activity. In suspension studies, chelating agents as compared to water generally increased the amount of soluble radionuclides but the effect was small. The effect of water and a chelating agent on the movement of radionuclides in soil columns were also studied. (auth)

36662 SOME LOCAL CHANGES OF THE TERRAIN GAMMA-FIELD CONNECTED WITH RADIOACTIVE FALLOUT. Dimchev, T.; Raichev, Kh. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk, 13: 31-42(1965). (In Bulgarian)

Local changes in the distribution of the terrain gamma field which are manifested chiefly in some mountainous localities were examined. Abrupt anomalously high values of the strength of the dose created by the gamma radiation from the terrain were noted. Studies were made of the terrain gamma-backgrounds over highland pastures and other grass-covered areas, and a very typical rise in the values was observed in comparison with areas not covered by grass. The results are given of measurements of the gamma background in haystacks from pastures from the various highland areas. Gamma-spectroscopic and radiochemical studies were made of soil and other samples in order to elucidate the origin of the anomalies observed. The experimental material makes it possible to identify a number of radio-isotopes, the products of the fission that have fallen on the surface of the ground as a result of the dispersal of the radioactive fallout in the atmosphere. The analysis of the material from the field and laboratory investigations indicates the presence of a new phenomenon—the local accumulation of fission products due to global contamination which is the result of nuclear tests. Some of the concentrations of fission products found in the soil are very high and give grounds to assume the presence of active factors of the transportation and migration of fission products which have fallen from the atmosphere on the ground. The approximate age of the mixtures of radioisotopes was determined, and the ratio of the basic-long-lived products cerium-144 and cesium-137 was determined. The results published come from an investigation which is still in its initial stage and which does not claim to be comprehensive. It was established beyond any doubt, however, that the radioactive fallout, concentrating under the action of meteorogical, hydrological, orographical and other factors, may create a very high level of local radioactive contamination even under the conditions of global dispersal of long-lived products which originated from the stratosphere reservoir. The possibility of making a direct measurement of the anomalies in the distribution of the terrain gamma background which has been created as a result of this, was shown in the course of the investigations. (auth)

36663 THE ARTIFICIAL RADIOACTIVITY OF THE ATMOSPHERE OVER EUROPE AND ITS RELATIONSHIP WITH METEOROLOGICAL CONDITIONS IN THE PERIOD 1959-1963. Troshev, T. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk, 13: 47-60(1965). (In Bulgarian)

As a result of daily measurements of the artificial radioactivity of the air and the precipitation in several points over Europe in the period 1959–1963, a comparison was made of the data obtained, and comparative charts were drawn. The period under review is marked by the testing of megaton nuclear devices over the ground and the double contamination of the atmosphere with radioactive aerosols. It is seen from the comparison of the data obtained from various points in Europe that the high activities in the atmosphere are dispersed very quickly. Maximum values of the recorded high artificial radioactivity are observed in regions of a cyclonic character and in the spring and the autumn when the atmosphere is more turbulent. The anticyclone regions with their typical movement of air masses from the upper layers of the troposphere towards the surface of the Earth and the great immobility of the air mass under favorable conditions may also lead to a high radioactive contamination of the air of certain regions. (auth)

36664 A SOIL-GAS EMANATION MEASUREMENT SYSTEM USED FOR RADON-222. Pearson, John E.; Rimbey, Donald H.; Jones, Gary E. (Univ. of Illinois, Urbana). J. Appl. Meteorol., 4: 349-56(June 1965).

The transfer of various gases through the soil-atmosphere interface is of interest to agronomists, meteorologists, biologists, and many others. Such gases include carbon dioxide, water vapor, and radon. A system applicable to measurements of the emanation of gases was developed and used to investigate the emanation of ^{222}Rn. The instrumentation was designed so that the variation of soil gas emanation with time, wind speed, soil moisture, soil type, and geographical location could be studied. The system measured a net transport through the earth-atmosphere interface of 1.1 ± 0.6 atoms of ^{222}Rn per square centimeter per second (mean of 27 means, eight samples each, ± standard deviation of 27 means). For a set of eight samples collected on a given site, the coefficient of variation was 0.3 to 0.4. The analysis of a single sample provided the amount of ^{222}Rn collected with an error of about 5%. The system is completely portable, including the power supply, and can be carried from a vehicle by two men. It was designed to minimize disturbance of the site at all times, providing air flow and pressure within the collecting apparatus comparable to those in nature during sampling. Sampling sites can be chosen as desired, and all equipment can be removed from the site when sampling is completed. During a sampling trip to the Rocky Mountains, the equipment was transported 3000 miles without any breakage. Throughout an experiment on the diurnal variation of radon emanation, two duplicate systems were operated 12 hours each without difficulty. (auth)

36665 THE CONTENT OF URANIUM IN QUARTZ OCCURRING IN SOME LOCALITIES OF TAITUNG. Cheng, Hwa-Sheng; Lin, Ching-Yu; Ke, Chiung-Huei. J. Chinese Chem. Soc. (Taiwan), 11: 185-92(Dec. 31, 1964).

Radioactive minerals other than Hokutolite and monazite are unknown up to the present in Taiwan. The hard green copperiferrous quartz found in north Taitung and collected by two field survey teams, exhibited measurable activity, the origin of which was found to be uranium in these samples ranged between 0.002 and 0.035%. It was also found that uranium was accompanied with copper, and that inclusion of iron in the sample decreased the uranium content. The content of uranium in talc and monazite concentrate was also determined. (auth)

36666 RELATION BETWEEN AMOUNT OF CESIUM^{137} IN COWS' FEED AND MILK. Kahn, B.; Jones, I. R.; Carter, M. W.; Robbins, P. J.; Straub, C. P. (Oregon State Univ., Corvallis). J. Dairy Sci., 48: 556-62(May 1965).

The intake and milk concentrations of ^{137}Cs were measured for a herd of cows continuously on pasture for 19 days, then transferred to a diet of stored feed for 36 days. Similar measurements were performed on control herds maintained on either pasture or stored feed. The decrease of ^{137}Cs concentration in the milk of cows thus transferred from a relatively high ^{137}Cs diet to a low one was examined, as well as the ratio of ^{137}Cs concentration in milk to the intake under constant feeding conditions. All the ^{137}Cs originated in fallout and contaminated the feed under environmental conditions. During May and June, 1963, three groups of Jersey and Holstein cows that had been given stored feed were used. One herd continued eating stored feed, the second was placed on pasture, and the third was placed on pasture for 19 days and then returned to eating stored feed. Cesium-137 was determined in daily samples of pasture grass, hay, grain, silage, drinking water, air particulates, and milk by radiochemical and γ-spectral analyses. Food consumption and milk production were measured, and water and air intakes estimated. The intake of ^{137}Cs by the pastured cows was ~ten times as great as that by the cows consuming stored feeds. Cesium-137

levels in milk were directly proportional to intake, in that 13% of ^{137}Cs was transferred to the milk. When the herd was returned from pasture to stored feed, ^{137}Cs in milk decreased rapidly; 59 and 36% of the total, respectively, had 0.8-day and 4-day half-times. Between May 3 and 19, 1963, pasture grass contained average ^{137}Cs and potassium concentrations of 4.3 nC/kg and 26 g/kg, respectively. The ^{137}Cs concentration in airborne particles varied between 0.06 and 0.34 pC/m^3; in water, it was below the min detectable value attainable for the sample volume. Neither medium was found to contribute significantly to the intakes of ^{137}Cs or potassium. (BBB)

36667 RADIOACTIVE FALLOUT PARTICLES COLLECTED BY AN ELECTROSTATIC PRECIPITATOR. Huzita, Akira; Mamuro, Tetsuo (Radiation Center of Osaka Prefecture, Osaka). J. Geomagnet. Geoelec., 16: 221-8(1964).

A Gerdien type of ion chamber was used as an electrostatic precipitator to collect radioactive fallout. Aerosol particles were collected on different parts of the central electrode according to their ionic mobilities. The dust samples thus collected were investigated by γ-ray spectrometry and microautoradiography. The experimental results indicate that aerosol particles which are attached by primary fallout particles of higher activity are charged multiply resulting in higher ionic mobilities presumably because they get a positive unit charge when they emit a β ray. This is in contrast with the fact that natural aerosol particles mostly become charged singly through attaching ions produced by natural radiation and radioactivity. (auth)

36668 K/Rb RATIOS IN TEKTITES. Pinson, W. H. Jr.; Philpotts, J. A.; Schnetzler, C. C. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 70: 2889-94(June 15, 1965).

The K/Rb weight ratios and individual K and Rb contents are reported for 54 tektites. Twenty-nine of these analyses are new. The ranges of K/Rb ratios found in the present investigation for tektites from the different localities are: australites, 151-185, 4 samples; javanite, 162; philippinites, 169-174, 7 samples: indochinites, 166-178, 8 samples; Ivory Coast, 209; moldavites, 197-238, 30 samples; North America, 249-267, 3 samples. Thus the Pacific area, North American, and Czechoslovakian tektites fall into three distinctive K/Rb ratio groups. Potassium was determined by flame photometry, 23 of the moldavite analyses being confirmed by x-ray fluorescence. Rubidium was determined by x-ray fluorescence with standardization and numerous cross checks by mass-spectrometric and stable-isotope-dilution analyses. G-1 and W-1 were used as analytical monitors. Precision and accuracy for the ratios are better than ±4%. Variations of the K/Rb ratios within a group are interrupted as resulting from differential volatilization rates for K and Rb during high-temperature fusion, whereas differences between the geographical groups are thought to reflect initial compositional variations in the parent materials. (auth)

36669 THE ISOTOPIC COMPOSITION OF TERRESTRIAL AND METEORITIC TIN. de Laeter, J. R.; Jeffery, P. M. (Univ. of Western Australia, Nedlands). J. Geophys. Res., 70: 2895-2903(June 15, 1965).

The relative isotopic composition of tin extracted from 22 terrestrial samples, 4 iron meteorites, and the metal phase of 1 mesosiderite was measured in a solid-source mass spectrometer. No differences greater than 1% were found in the abundances of masses 116 to 124 or greater than 5% for masses 112 and 114 in any of these samples with respect to a tin standard. (auth)

36670 RARE-EARTH ELEMENTS IN OCEAN SEDIMENTS. Wildeman, Thomas R.; Haskin, Larry (Univ. of Wisconsin, Madison). J. Geophys. Res., 70: 2905-10 (June 15, 1965).

The content and relative abundance distributions of rare-earth elements were determined in eight samples of ocean sediments. For any particular rare earth, the variation in absolute concentration among the samples did not exceed a factor of 3. The average rare-earth relative abundance distribution for the ocean sediments was the same as that reported previously for limestones, sandstones, and shales. This distribution is distinctly different from that found in ocean water, but this does not imply a state of disequilibrium. (auth)

36671 MEASUREMENTS AT THE SOUTHERN MAGNETIC CONJUGATE REGION OF THE FISSION DEBRIS FROM THE STARFISH NUCLEAR DETONATION. D'Arcy, Raymond G.; Colgate, Stirling A. (Univ. of California, Livermore). J. Geophys. Res., 70: 3147-59(July 1, 1965). (UCRL-12056)

The fission products from the July 9, 1962, Starfish high-altitude nuclear detonation were measured with a recording gamma spectrometer near the southern magnetic conjugate point of the Starfish location. The transit time of 2 to 20 sec over the 4000-km flight path indicates that debris arrived both noninteracted and interacted with the earth's atmosphere at the point of detonation. Since the southern magnetic conjugate point is below the horizon relative to the detonation point, all measured debris must have been ionized and guided by the geomagnetic field. The large fraction of debris observed(~50%) indicates the dominance of the geomagnetic field interaction. The spatial distribution of debris indicates that the major fraction arrived on the flux tube (~300-km width, flux surface L = 1.12) conjugate to the detonation point with a 2° westward drift. Additional debris was observed distributed southward up to L = 1.29, indicating a partial penetration across the flux surfaces of the geomagnetic field. The injection of high energy electrons into trapped orbits around the earth is identified with the beta particle decay in transit of the observed debris. (auth)

36672 THE PHENOMENOLOGY OF THE MASS MOTION OF A HIGH ALTITUDE NUCLEAR EXPLOSION. Colgate, Stirling A. (Univ. of California, Livermore). J. Geophys. Res., 70: 3161-73(July 1, 1965).

The persistence of the free expansion of the detonation products of a high-altitude detonation is determined by the sum of the stresses of the environment. Below 200 km the classical dynamic friction with the air couples the detonation products to a very much larger mass of air. Above this altitude more uncertain plasma phenomena of magnetic and electrostatic shocks must be considered to determine this coupling. If a cubic scale height of air is raised to a temperature such that its sound speed is greater than escape velocity, it jets upward, and the ionized fraction is stopped and mixed unstably with the earth's magnetic field. The subsequent expansion along the field lines deposits the major fraction of the debris at the opposite conjugate point. The beta particle decay in transit on the various L surfaces reached by unstable mixing determines the high-energy electron injection into trapped orbits. For the Starfish event (1.4 megatons at 400 km), theory predicts that the detonation products and a cubic scale height of air expand upward until stopped by the earth's field at 1000 km. In addition, the deposition of the debris in the atmosphere at the southern conjugate point at 250-km altitude is expected to be dispersed over 300 km owing to magnetic field mixing. Approximately 5% beta injection into trapped orbits of L > 1.3 is expected. (auth)

36673 DETERMINATION OF THE MEAN RESIDENCE TIME IN THE TROPOSPHERE BY MEASUREMENT OF THE RATIO BETWEEN THE CONCENTRATIONS OF LEAD-210 AND POLONIUM-210. Lambert, G.; Nezami, M. (CEN, Saclay, France and Centre des Faibles Radioactivities, Gif-sur-Yvette, France). Nature, 206: 1343-4(June 26, 1965).

The concentration of ^{210}Po in rain water was lower than that that would result from radioactive equilibrium between ^{210}Pb and ^{210}Po. The decay chain for the process is as follows: $^{222}Rn \rightarrow$ radium-A,B, ... C' $\rightarrow ^{210}Pb \rightarrow ^{210}Bi \rightarrow ^{210}Po \rightarrow ^{206}Pb$. This lack of equilibrium was ascribed to the washing of radioactive aerosols present in the troposphere by rain. Measurement of the ratios of ^{210}Pb and

^{210}Po activities in rain water enables the residence time in the troposphere to be calculated. (F.J.H.)

36674 MEASUREMENT OF GAMMA RAY ENERGY DISTRIBUTION OF FALLOUT. Kasai, Atuchi (Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 14: 218-24(May 1965).

The variations of gamma distributions and the average gamma energy of fallout due to nuclear detonations from Sept. 1961 until Sept. 1964 are described. Fallout samples were collected with continuous dust samplers. The gamma spectra of the samples were measured by a 400-channel gamma spectrometer. The detector used was a sodium iodide crystal 5 in. $\phi \times 4$ in. and it was set in an ion box about 20 cm thick. Analysis of the gamma spectra were made by using the strip-off method. The energy ratio to the total gamma activities in the fallout was calculated from the net counting rate of the photo-peak. The ratio of gamma energy (0.76 Mev) from $^{95}Zr-^{95}Nb$ ranged from 50 to 88% in the period. The average gamma energy of the fallout in the period was nearly constant. The average value was 0.68 Mev. (auth)

36675 CARBON-14 CONTENT OF 18TH- AND 19TH-CENTURY WOOD: VARIATIONS CORRELATED WITH SUNSPOT ACTIVITY. Stuiver, Minze (Yale Univ., New Haven). Science, 149: 533-5(July 30, 1965).

A series of carbon-14 measurements of 18th- and 19th-century wood revealed an excellent correlation between the variations in carbon-14 content and average sunspot activity. It seems probable, therefore, that the predominant cause of the short-term fluctuations in carbon-14 activity is the variability of solar activity. (auth)

Techniques and Equipment

36676 (VESIAC-8422VU) DETERMINATION OF SOURCE PARAMETERS BY AMPLITUDE EQUALIZATION OF SEISMIC SURFACE WAVES. I. UNDERGROUND NUCLEAR EXPLOSIONS. Toksoez, M. N; Ben-Menahem, A.; Harkrider, D. G. (California Inst. of Tech., Pasadena. Seismological Lab.). May 1964. Contract AF49(638)-1337. 43p.

A method of determining the source parameters of explosions and earthquakes from the amplitude spectrums of seismic surface waves is described. The method, called amplitude equalization, involves the correction of the ground displacement spectrum for the propagation effect. This is accomplished by numerically multiplying it with the inverse of the frequency response of the layered medium. The result is the amplitude spectrum of the source function, which may be interpreted by itself or jointly with the initial phase spectrum to determine the source-time variation. The spectrums of the Rayleigh waves from underground nuclear explosions are compared and the source-time function is interpreted using the amplitude equalization method. The time variation of the pressure pulse at the boundary of the elastic zone is found to be of the form $p(t) = P_0te^{-\eta t}$ where η is a parameter which depends on yield of explosion and on the medium. For the events studies, the breadth of the pulse increased (η decreased) with the yield of the explosion. (auth)

36677 (VESIAC-5155) [PROGRESS REPORT ON SEISMIC DETECTION, OCTOBER-DECEMBER 1962]. Rocard, Yves; Lebel, Jean D. (ed.) (Association des Amis du Laboratoire de Physique de l'Ecole Normale Superieure, Paris (France)). Jan. 5, 1963. 40p.

The first section of this report deals with a comparison between seismic and gravimetric results in determining the curvature of the Mohorovicic discontinuity. Good agreement is obtained between gravimetric data and data obtained from the 1 May 1962 Sahara nuclear explosion and from underwater H. E. explosions in Italy. The second section of this report deals with coupling underwater and underground H. E. explosions. Data from underwater shots in the English Channel and from a large underground explosion in Germany are discussed. Finally, results of a seismic noise investigation are discussed. Noise from two close together seismic stations is compared. There is also an analysis of the earth motion in noise trains. (auth)

36678 NOTE ON THE VOLUME OF INFLUENCE OF A NEUTRON SURFACE MOISTURE PROBE. DeVries, J.; King, K. M. (Ontario Agricultural Coll., Guelph, Can.). Can. J. Soil Sci., 41: 253-7(Aug. 1961).

Experiments were made to determine the effect of the volumetric moisture content on the vertical and horizontal dimensions of the volume of influence of the neutron surface moisture probe, placed on the soil surface, and used along with an electronic scaler to determine the volumetric moisture content of the underlying soil. The effective measurement depth varies between 16 in. for dry soil and 5 in. for wet soil. It is also recommended that a container at least 24 in. square and 16 in. deep be used for lab calibrations. Test results showed that the vertical and horizontal dimensions decrease with increasing soil moisture content, which is in agreement with the manufacturer's information. For actual field measurement the depth of influence is the most important characteristic. It was concluded that the size of the box recommended is satisfactory for lab calibrations. A calibration curve was prepared and compared with the calibration provided with the probe by the manufacturer. Since the agreement was unsatisfactory over the entire soil moisture range, it was concluded that it is necessary to calibrate the probe before using it in the field. (BBB)

36679 SOME RESULTS OF EXPERIMENTS CONCERNING THE TECHNOLOGY AND INTERPRETATION OF DENSITY LOGGING. Andrassy, Laszlo; Sebestyen, Karoly. Geofiz. Kozlemen., 13: 49-60(1964). (In Hungarian)

Results obtained in experiments designed to develop the technology and interpretation of density logging are reviewed. A practical method is described for quantitative interpretation of the density logging, suitable for routine determination of rock densities. The theoretical background is summarized. (auth)

36680 AN INSTALLATION FOR MEASURING THE AMOUNT OF RADIOGENIC ARGON DURING DETERMINATION OF THE ABSOLUTE AGE USING THE POTASSIUM–ARGON METHOD. Doil'nitsyn, E. F.; Dmitriev, A. N.; Kozhevnikov, V. S. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 2, Ser. Tekhn. Nauk, No. 1, 96-103(1965). (In Russian).

Descriptions are given of the design and performance of a device for separation, purification, and measurements of radiogenic argon. The accuracy of the device was verified with specimens from Precambrian to Cretaceous period. The age determination by the amount of argon measured with the device was in agreement with available data. (R.V.J.)

36681 NEW TECHNIQUES OF WATER SAMPLING FOR CARBON 14 ANALYSIS. Crosby III, James W.; Chatters, Roy M. (Washington State Univ., Pullman). J. Geophys. Res., 70: 2839-44(June 15, 1965).

Methods commonly used in collecting fresh-water samples and stripping them of CO_2 for ^{14}C analysis are tedious and time consuming. The use of ion exchange resins for this purpose is advocated. Equipment has been developed, utilizing anion exchangers, which can be adapted to pump-site sampling, to in-well sampling, or to the sampling of surface waters. Analytical results, by means of which resin techniques and standard methods are compared, have proved to be within the normal errors expected in the ^{14}C method. The resin techniques may actually decrease experimental error by greatly reducing the possibility of atmospheric contamination. (auth)

36682 RUBIDIUM-STRONTIUM AGE OF SOME METAMORPHIC ROCKS FROM THE LLANO UPLIFT, TEXAS. Zartman, R. E. (Geological Survey, Washington, D. C.). J. Petrol., 6: 28-36(Feb. 1965).

Chemical and isotope-dilution procedures were used for Rb-Sr analyses. In addition to the isotope-dilution analyses, unspiked Sr compositions were determined for material less than 25% radiogenic. The Sr data were normalized to a $^{86}Sr/^{88}Sr$ ratio of 0.1194. The analytical results, expressed as $^{87}Sr/^{86}Sr$ and $^{87}Rb/^{86}Sr$ atom ratios, and Rb, and Sr concentrations, are given. Four total-rock samples of the Valley Spring gneiss gave a Rb-Sr isochron age of 1120 ± 25 Myr and an initial $^{87}Sr/^{86}Sr$ ratio of 0.706 ± 0.002. This age is significantly older than the 1000 to 1050 and 920 ± 20 Myr dates previously determined for the igneous rocks of the Llano Uplift. Mineral isochrons for the individual gneiss samples yielded an age of metamorphism of 1000 ± 15 Myr, in good agreement with the time of major plutonism. The Sr in each of the older metamorphic rocks was isotopically homogenized at this time, resulting in $^{87}Sr/^{86}Sr$ ratios ranging from 0.716 to 0.775. From the data it was concluded that the plutons, which appear to have formed contemporaneously with a $^{87}Sr/^{86}Sr$ ratio of 0.706, could not have obtained their Sr from the surrounding metamorphic rocks unless some special mechanism operated to remove excess radiogenic Sr. Only if the granite remained an open system, unable to retain radiogenic Sr during its early history, could it be as old as the total-rock age of the gneiss. A lower crustal or mantle source for the strontium in the granite would be more likely to account for an initial $^{87}Sr/^{86}Sr$ ratio of 0.706. If the igneous and the metaigneous rocks are genetically related and initially began with a similar Sr isotopic composition, the only value of the $^{87}Sr/^{86}Sr$ ratio which could have existed simultaneously in both of them is 0.705 ± 0.001 at 1025 ± 20 Myr ago. This suggests that the granite magma did not exist with its present Rb/Sr ratio, as a closed rock system, for an appreciable length of time preceding its crystallization and mineral age retention. (BBB)

36683 STRONTIUM ISOTOPE ABUNDANCE STUDIES AND RUBIDIUM-STRONTIUM AGE DETERMINATIONS ON TERTIARY IGNEOUS ROCKS FROM THE ISLE OF SKYE, NORTHWEST SCOTLAND. Moorbath, S.; Bell, J. D. (University Museum, Oxford, Eng.). J. Petrol., 6: 37-66(Feb. 1965).

The application of Sr isotope abundance variations to the problem of the origin of igneous rocks is discussed. A comparative study of initial $^{87}Sr/^{86}Sr$ ratios was undertaken for representative types of basaltic and granitic rocks from the Isle of Skye on the basis of the hypothesis that if the initial $^{87}Sr/^{86}Sr$ ratios of rocks from the acid intrusive centers are significantly greater than values obtained on the basaltic and gabbroic rocks, then the former could not have been derived by differentiation from basalt magmas. When the isotopic abundance of Sr was measured in representative rock-types from the tertiary igneous suite in the Isle of Skye, northwest Scotland, the isotopic abundance of ^{87}Sr, expressed as the $^{87}Sr/^{86}Sr$ ratio, for 12 basalts, dolerites, gabbros, and peridotites was 0.7058 ± 0.0010. On the other hand, the average initial $^{87}Sr/^{86}Sr$ ratio for one granite from the Eastern Redhills Complex and for three granites from the Western Redhills Complex was 0.7124 ± 0.0015. The three principal members of the marscoite, also have significantly higher initial $^{87}Sr/^{86}Sr$ ratios than the basaltic rocks. It was concluded that the rocks with high initial ratios were derived from a source with significantly higher Rb/Sr ratio than that of the basaltic rocks. The isotopic evidence is, however, in general accord with the hypothesis that marscoite was produced by the mixing of partly crystallized magma of ferrodiorite and porphyritic felsite compositions in the proportion of about 60 : 40. (TCO)

36684 FOUR NEW URANIUM-LEAD AGES FROM CORNWALL. Pockley, R. P. C. (Oxford Univ.). Mineral. Mag., 33: 1081-92(Dec. 1964).

Four new isotopic U/Pb ages from Cornwall are reported. The $^{206}Pb/^{238}U$ and $^{207}Pb/^{235}U$ ages for each specimen are concordant. The $^{206}Pb/^{238}U$ ages are: South Terras mine 225 ± 5 million years (Myr), Redruth Area 124 ± 4 Myr, Wheal Owles mine 58 ± 3 Myr, and Smith Terras Area 62 ± 3 Myr. Cell sizes, calculated from x-ray powder photographs, decrease with decreasing ages of the specimens, indicating a progressive increase in the oxidation states of the U present. It was concluded that: primary mineralization occurred in southwest England at about 290 Myr and 225 Myr; at about 60 Myr there was either localized remobilization (during which the older U minerals suffered partial loss of radiogenic Pb together with oxidation of the U in corresponding proportions) or further primary mineralization, or a combination of these two processes; and the significance of the single 124 Myr age is uncertain; it could represent a real geological event (either remobilization or primary mineralization) or it could represent a mean between several unidentifiable events of other ages. The process of remobilization, regeneration, rejuvenation, or redistribution has been recognized independently and is the explanation favored on the data available so far. (TCO)

36685 A NONCONTAMINATING PROBE FOR INJECTING RADIOACTIVE SOLUTION INTO SOIL. Kafkafi, U. (Volcani Inst. of Agricultural Research, Rehovoth, Israel). Soil Sci. Soc. Am. Proc., 29: 324-5(May-June 1965).

A probe was constructed in order to place accurately small volumes of radioactive solution in soils up to a depth of 160 cm. The implement had the advantage of delivering the solution at its very end. It was constructed of an iron pipe with a rubber cap at the end of it. Inside the pipe there was a movable brass tube with a hypodermic needle at its end. By pushing down the brass tube the needle was forced out of the protecting rubber cap. A plastic tube was tightly connected to the hypodermic needle at one side and to a source of solution at the other side. The solution flowed from a container by gravitation, and the amount was controlled by counting the drops. With such a probe, 0.5 cm^3 was placed accurately in 1,400 holes varying from 20 to 120 cm in depth in 12 work hours when the access holes were prepared by another team. (auth)

36686 ON THE PROBLEM OF THE FLUCTUATION OF THE RATIO OF ISOTOPES $^{39}K/^{41}K$ IN SOIL POTASSIUM. Kaviladze, M. Sh.; Abashidze, I. V. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR, No. 1, 67-74(1964). (In Russian)

Description of a variant of an ion emitter is given. The $^{39}K/^{41}K$ ratio was determined in 29 rock samples using a mass-spectrometer. The variation was found not to exceed 25%. A new method for doing this type work with an accuracy of ±0.03−0.04% is described. (CFSTI)

36687 RADIOACTIVE INVESTIGATIONS OF OIL AND GAS WELLS. A Textbook. Barsukov, O. A.; Blinova, N. M.; Vybornykh, S. F.; Gulin, Yu. A.; Dakhnov, V. N.; Larionov, V. V.; Kholin, A. I. A Pergamon Press Book. New York, The Macmillan Company, 1965. 305p. $12.00.

Translated by J. O. H. Muhlhaus from Radioaktivnye Metody Issledovaniya Neftyanykh i Gazovykh Skvazhin.

The theory and state-of-the-art of radioactive methods of well logging are discussed. Topics covered include: physical principles of the radiometry of wells, radioactive properties of rocks, methods of well radiometry, radiometric apparatus, principles of the γ-method of well logging, measurements by the natural radioactivity method, interpretation of diagrams of the scattered gamma-radiation method, neutron-induced gamma or neutron methods for well logging, neutron methods for subdivision of reservoir rocks according to oil-water saturation, and working techniques and interpretation of diagrams of the tracer method. (M.C.G.)

36688 CONTROL SYSTEM FOR ARTIFICIAL SOURCES OF RADIATION. Hopkinson, Eric C. (to Dresser Industries, Inc.). U. S. Patent 3,176,136. Mar. 30, 1965. Filed Sept. 29, 1961.

A system for artificially producing radioactivity is described in which the output flux of the source is closely controlled. The system is particularly useful in radioactivity well logging and includes an ion beam accelerator

tube, an electrostatic generator arranged and adapted to supply the tube with a relatively constant accelerating voltage, and an endless belt adapted to carry an energized electric current to the tube. Belt-charging means and variable belt-charging means are interconnected with the generator. A radiation detector is arranged in close proximity to the tube and provides a monitor signal generally composed of electrical pulses functionally related to the incident radiation on the detector. Comparing means are interconnected to receive the monitor signal and to derive from it a compensating signal that is connected to the belt drive. (B.L.M.)

Thorium and Uranium Minerals

Refer also to abstracts 36296 and 36684.

36689 (RME-4544(Rev.)) RECONNAISSANCE FOR URANIUM IN MATO GROSSO STATE, BRAZIL. Gabelman, John W. (Division of Raw Materials (AEC), Washington, D. C. and Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro). Dec. 1963. 22p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

Brief reconnaissance for uranium in the Corumbá and Aquidauana areas of Mato Grosso State, Brazil, revealed no economic uranium deposits. In the former area there was only weak hydrothermal activity, with pyrite probably being the only known significant metallization product. The area is deficient in favorable lithologic or structural traps into which uranium could have been laterally secreted from nearby uranium-bearing rocks, and uranium is not associated with the extensive sedimentary iron and manganese deposits. However, small uranium deposits may have resulted from the weak hydrothermal activity. Hydrothermal copper-uranium mineralization occurs in the Morro Grande uplift at the Fermiani prospect in the Aquidauana area. Additional reconnaissance may detect other, more significant anomalies in this uplift, inasmuch as conditions are ideal for low-temperature hydrothermal uranium mineralization as well as for lateral secretion of uranium from uraniferous granite into marginal arkose. (auth)

36690 (NSJ-tr-20) PROSPECTING AND DEVELOPMENT OF URANIUM DEPOSITS OF NINGYO-TOGE URANIUM FIELD IN JAPAN. Translated from Mining Geol. (Tokyo), 14: No. 63, 1-10(Feb. 1963). 21p. Dep. mn; JCL, $2.60 fs, $0.83 mf.

Prospecting operations were carried out in the so-called "massif" region consisting mainly of granites. The first discovery of uranium mineralization in sedimetary rocks was made by a car-borne team at Ningyo-toge in the Chugoku massif, Southwest Japan. It was confirmed by geological research that the uranium minerals occur in conglomerates and sandstones of the Neogene Tertiary unconformably overlying the granites. Trenching, geophysical and geochemical prospecting, drilling and tunnelling were carried out. As the result of these operations, three million tons of the ore reserves containing two thousands tons of uranium metal have been recognized. The uranium ores of Ningyo-toge are soft and porous, and the uranium minerals occurring as fine-grained crystals in the matrix are easily soluble in acid. Such characteristics of the ore enable one 1) to raise their grade several times as high by washing and screening, 2) to exploit by the hydraulic method, and 3) to extract the uranium under mild conditions. There are almost no minerals containing elements which interfere with the refining process or possess high cross section for neutron absorption. (D.L.C.)

36691 (JPRS-30963) BEDS OF URANIUM IN YUGOSLAVIA. Jankovic, Slobodan. Translated from Tehnika (Belgrade), No. 5, 877-84(May 1965). 24p. (TT-65-31461) CFSTI, $1.00 cy.

Studies of uranium beds and uranium-bearing regions were made to obtain a generalized picture of the conditions under which uranic concentrations have been created and their regional distribution in Yugoslavia. The kinds of beds studied include pegmatites, pneumatolytic beds, hydrothermal beds, infiltration beds, and sedimentary beds. (D.L.C.)

36692 USE OF TRACER ELEMENTS IN THE EVALUATION OF RADIOACTIVE ANOMALIES IN ARID CLIMATE REGIONS. Konstantinov, V. M. At. Energ. (USSR), 18: 657-9(June 1965).

Geochemical studies of arid climate regions found that in the areas bearing radioactive ore anomalies the mellow soils showed the presence of dispersion halos of uranium, lead, zinc, cobalt, molybdenum and arsenic which are the elements forming the endogenic dispersion halos around uranium ore bodies. In places where uranium anomalies were absent only uranium and lead traces were present. It was suggested that in arid climate areas the tracer elements of uranium deposit dispersion halos can be used in prospecting for radioactive ore-bearing anomalies. (R.V.J.)

36693 VARIATION IN THE CONTENT OF URANIUM AND THORIUM ACROSS IGNEOUS CONTACTS. Nishimura, Susumu (Kyoto Univ.). Mem. Coll. Sci. Univ. Kyoto, Ser. B., 31: 227-38(Feb. 1965).

Variations in the content of uranium and thorium were traced across igneous contacts of the two intrusions of Tanakami and Koya with serial samples by the use of a combined technique involving an α-scintillation counter and a radioscope. The results showed that the types of the distribution of α radioactivity across igneous contacts found by a radioscope depend mostly on the content of uranium. On the other hand, the thorium content varied markedly from sample to sample, but the average values of it near the contact were nearly constant and equal to that of the inner part of the intrusive body. Thus the thorium content varies more markedly than that of uranium, showing a tendency of increasing against the contact plane. This difference can be attributed to the different geochemical character of the uranium and thorium. As the uranium moves as volatile matter under large differences in temperature and pressure between granitic body and country rocks, it can be deposited in appreciable quantities within thin layer of contact, but this tendency is less marked with thorium. With small differences of temperature and pressure which is conceivable near the contact of great depth, uranium may be deposited equally over the intrusive body. This concept is supported by the variation of grain-size across the igneous contact of a granitic body. A part of the variations of the uranium content across igneous contacts may be explained in this way. On the other hand, the variation of thorium content suggests the absence of such diffusion as considered in the case of uranium in hexavalent form. (TCO)

36694 THE RELATIONS BETWEEN THE PETROLOGY AND THE RADIOACTIVITY OF SOME GRANITIC BODIES. (2). Nishimura, Susumu; Katsura, Kyozo; Kusakari, Hideshige (Kyoto Univ.). Mem. Coll. Sci. Univ. Kyoto, Ser. B. 31: 239-54(Feb. 1965).

The distribution of radioactive elements in granitic intrusive rocks was studied. The results of determinations of radioactivity using a radioscope, an α-scintillation counter, and a low-background gas-flow counter are reported. The tendency of the radioactive elements to concentrate towards the periphery of the intrusive mass, to increase with SiO_2 and KO_2 content, and to be modified in content by weathering was noted. Variation of the α radioactivity of different grain sizes of granitic masses was also found. It is shown that the α radioactivity of the samples from the core of intrusives increases with increasing grain size while β radioactivity does not show such a relation. The original granitic rocks would have undergone oxidation and leaching through weathering and erosion. Under such conditions the uranium may be oxidized to a very soluble uranyl form and be carried away by ground and surface water. Thorium, on the other hand, cannot be oxidized under usual geologic conditions to a hexavalent state to form an analog of uranyl ion. This aspect of weathering is partly responsible for the wide dispersal of uranium,

and also gives rise to a very low Th/U ratio observed in natural water. The rock samples were classified into five grades according to the degree of apparent weathering. The relation between this degree of weathering and radioactivity is shown. From these results, it was found that α radioactivity increases with advancing weathering, but β radioactivity does not. (BBB)

36695 NEW ESTIMATES OF WORLD URANIUM NEEDS. S. African Mining Eng. J., 75: 965(Apr. 30, 1965).

Estimates of the demand of U over the next 10 to 15 yrs are discussed, with a consideration of the effects of expected increased demands for U on price, exploration, and production of U. The latest long-range projections on the use of nuclear power by U. S. authorities indicate a more rapid rate of growth, and consequently in U requirements, than was forecast in 1962. It is now expected that by 1975, the annual domestic requirements of the U. S. will be between 9,000 and 14,000 tons of U_3O_8, and the total requirements of the free world will be between 23,000 and 33,000 tons. Moreover, in the following five years up to 1980, yearly world requirements are expected to double. If this forecast is correct the pressure on recovery facilities would be such that a rise in the price of U would be inevitable. The A.E.C. estimates that the price of U will begin to climb in the early mid-1970's reaching a figure of about $8 per lb in the late 1970's. However, successful exploration and development of new mines would tend to hold prices in check, and advanced converter and breeder programs should also stretch U reserves and have some stabilizing effect on prices. U reserves (available at about $8.00 per lb) in the free world amount to more than 500,000 tons, more than 80% of which is in three countries, Canada, South Africa, and the United States. The development of advanced reactors will serve to permit the nuclear power industry to grow at rates that are not inhibited by possible undue price increases of U. This will assure the continued growth of the mining segment of the nuclear industry. (BBB)

36696 URANIUM AND RADIUM IN THE WESTERN NORTH PACIFIC WATERS. Miyake, Y.; Sugimura, Y. (Meterological Research Inst., Tokyo). pp 274-8 of Studies on Oceanography. Tokyo, Univ. of Tokyo Press, 1964.

The vertical profile of radium and uranium in sea waters, collected along 38°N extending from 143 to 148°E in the western North Pacific was studied. Radium was determined by the α spectrometric method after isolating it from precipitate of barium and radium rhodizonate with cation exchanger. Uranium was analyzed by the absorption-spectrophotometric method using dibenzoylmethane after separation with solvent extraction and anion-exchange. Radium content in sea water ranged from 0.4 to 0.6×10^{-13} g/l at the surface and from 0.9 to 1.3×10^{-13} g/l at the bottom. The mean value was 7.3×10^{-14} g/l. The analytical result of uranium showed that its content in sea water varied considerably on both horizontal and vertical directions ranging from 1.9 to 4.7×10^{-6} g/l. Average content of uranium was 3.4×10^{-6} g/l which is in good agreement with the mean value of 3.3×10^{-6} g/l. It was noted that the uranium content also increases with the depth. Observed values of the ratio of radium to uranium were only six to ten % of the equilibrium amount. (auth)

HEALTH AND SAFETY

See also BIOLOGY AND MEDICINE — Radiation Hazards and Protection.
GEOLOGY AND MINERALOGY — Natural Radioactivity and Fallout

Refer also to abstracts 36745, 36823, 37198, 38083, and 38175.

36697 (AWRE-O-29/65) A PRELIMINARY EVALUATION OF THE BIOLOGICAL MEASUREMENTS ON OPERATION ROLLER COASTER (JOINT US/UK EXPERIMENTS). Stewart, K.; Thomas, D. M. C.; Terry, J. L.; Wilson, R. H. (Atomic Weapons Research Establishment, Aldermaston (England)). July 1965. 33p. Dep. mn; BIS, $1.00, HMSO, 5s. 0d.

The deposition and lung retention of inhaled Pu particles by burros, dogs, and sheep were studied following the inhalation of particulate matter produced as the result of the detonation of a chemical explosive in a nuclear weapon containing Pu metal. The quantities of Pu collected by the animals were compared with those collected by adjacent air sampling instruments. Results obtained with cascade impactors are summarized and measured lung burdens are summarized for the 3 species. Results indicate that the pattern for lung clearance is different for each species, and hence may be different for man. However, simple relationships were observed between the median value for the initial deposition and the ratio of the breathing rate to the body and lung weights. This supports the conclusion that results obtained with the 3 species are comparable and are also comparable with the existing data for man. (C.H.)

36698 (BM-RI-6516) EXPLOSIBILITY OF METAL POWDERS. Jacobson, Murray; Cooper, Austin R.; Nagy, John (Bureau of Mines, Pittsburgh, Pa. Health and Safety Research and Testing Center). Mar. 1964. 25p. Free (Bureau of Mines).

Data obtained on dust explosions of 313 elemental metals, alloys, catalysts, and ores comprising 54 types of material are summarized. Information is given on ignition temperature, spark energy for ignition, minimum explosion concentration, explosion pressure, rate of pressure rise, and in some instances, the admixed inert dust and oxygen concentration in an atmosphere required to prevent ignition of dust dispersions. The effects of particle diameter on explosibility and pyrophoricity are also discussed. (auth)

36699 (BNWL-SA-5) THE HANFORD EMERGENCY DOSIMETRY SYSTEM. Larson, Harold V.; Keene, Arthur R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 1965. Contract AT(45-1)-1350. (CONF-650302-20). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna.

Instrumentation, communication systems, procedures, and training to minimize the time of radiation exposure, effecting prompt identification and medical treatment for those exposed, and estimating the radiation dose to personnel associated with the incident in the event of a criticality accident are discussed. Procedures for estimating radiation dose are based upon whether or not personnel dosimeter data are available, types of radiation involved, magnitude of exposure, and areas or organs of the body irradiated. Topics discussed include communications and mobilization systems; radiation alarms; building evacuation; personnel accounting and segregation; methods and instruments for the assessment of neutron, x, and γ radiation dose; dosimetry evaluations for personnel wearing dosimeters; the assessment of internal and critical organ dose; dosimetry evaluations for personnel not wearing dosimeters; the value of stationary dosimeters; and criteria for the placement of stationary dosimeters. The organization and activities of emergency radiological teams are discussed briefly. (C.H.)

36700 (BNWL-SA-9) ENVIRONMENTAL EXPOSURE AS A FUNCTION OF CONTAINMENT VESSEL LEAKAGE RATE. Watson, E. C.; Wittenbrock, N. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 25, 1965. Contract AT(45-1)-1830. 40p. (CONF-650407-9). Dep.(mn); $2.00(cy) 1(mn) CFSTI.

From International Symposium on Fission Product Release and Transport Under Accident Conditions, Oak Ridge, Tenn.

A study was made of different containment conditions in the PRTR in case of an accident and of the effects of the varying leakage rates on environmental exposure. The cases of containment with and without water fog spray and confinement with and without water fog spray were analyzed. Fission product leakage rates and total body doses were calculated for each case. (D.L.C.)

36701 (CIRA-3) CRITICAL INDUSTRY REPAIR ANALYSIS — FOOD INDUSTRY. Final Report. Fernald, Olaf H.; Bull, Thomas D. (ed.) (Advance Research Inc., Needham Heights, Mass.). Apr. 1965. Contract OCD-OS-62-257. 378p.

The American food industry is analyzed in terms of vulnerability and postattack repair. Processing plants in eight specific segments of the industry are selected on the basis of essentiality and vulnerability: flour, yeast, sugar, citrus fruit, edible oils, fish, meat, and packaging (cans and cartons). Vulnerabilities of the plants vary by a whole order of magnitude. The most vulnerable plant faces total destruction at a relatively low 1.2 psi blast overpressure, and the least vulnerable plant is still repairable after a blast of up to 12.0 psi. The older, more massively built plants are generally least vulnerable, hence present the fewest repair problems at any given blast level. There are two general conclusions. First, a severe shortage of both raw and processed food stuffs is improbable, because food manufacturers are both numerous and geographically dispersed. Second, food in one form or another, including ample reserves in the form of stored, surplus commodities, will be available but must be transported. An adequate supply of petroleum is essential to insure the transportation which will provide the food supply. (auth)

36702 (EUR-2407.f) ASPECTS SCIENTIFIQUES ET SANITAIRES DE LA CONTAMINATION RADIOACTIVE DE LA MER. (Scientific and Health Aspects of Marine Radioactive Contamination). Recht, P.; Van Hoeck, F. (European Atomic Energy Community). 1965. 59p. (CONF-640530-1). Dep. mn.

From International Congress on the Sea, Saint-Cast, France.

Scientific and health aspects of the marine contamination resulting from the disposal of radioactive waste at sea are reported, and factors to be considered from the health and biology standpoint are surveyed. The physical and chemical components of the marine environment are reviewed. The irradiation doses received from natural background radioactivity are specified. Particular attention is paid to the biological factors that must be taken into account in evaluating the degree of radioactive contamination. The artificial radioactivity found in the marine environment stems mainly from radioactive fallout but also, within limited areas, from discharged radioactive waste. The problem of radioactive waste is discussed, with a summary of the data concerning its origin, composition and classification. At present such waste is disposed of in three ways: as liquid effluents discharged into coastal waters; in submerged drums; and as liquid and solid effluents from nuclear-powered ships. Difficulties encountered in experimental biological work in a

marine environment are discussed. A sample research programme is presented. (auth)

36703 (HW-72229(Rev.)) DOSE-RATE MEASUREMENTS ON BEACHES AND ISLANDS ON THE COLUMBIA RIVER BETWEEN RINGOLD AND RICHLAND. McConnon, D. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Aug. 10, 1962. Contract AT(45-1)-1350. 22p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Radioactive materials released with the effluent of the Hanford production reactors can provide measurable radiation exposure to persons who use the Columbia River downstream. Dose rates measured on beaches in the Ringold to 300 Area section of the river were in the range of 0.05 to 1.1 mR/hr with maximum values near the water's edge. Dose rates in the water were in the range of 0.05 to 0.2 mR/hr. March and October values, obtained at a river flow of 50,000 cfs and 60,000 cfs, respectively, were about twice those observed in July at a river flow of 175,000 cfs. In general, the levels of contamination found in the Ringold to 300 Area section were not appreciably different from those which exist in the vicinity of Richland where the river is now used extensively for recreational purposes. (auth)

36704 (NP-15105) METOD NEPRERYVNOGO KONTROLYA VELICHINY "SKRYTOI" ENERGII. (Method of Continuous Monitoring of the Magnitude of Latent Energy). Report No. 108. Markov, K. P.; Ryabov, N. V.; Stas, K. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). [1964]. 14p. Dep.(mn).

Problems of continuous monitoring of the latent energy of radon daughter products were studied using a continuous moving filter belt and a filter with periodic motion. Precipitation of dispersion phase aerosols on the continuous filter belt combined with effective control of the relation between the number of the RaA and RaC alpha decays, and the magnitude of the latent energy proved more efficient than more complex operations with periodic belts. The method with continuous monitoring permitted a statistically correct estimate of E_d magnitude at a range from 6.5×10^2 to 6.5×10^5 Mev/l. A continuous belt scheme with combined distribution of pumping window (a sampling section of the belt) and detector and a scheme with a less rigid distribution, where the RaA and RaC atoms can be measured at any belt point in front of the detector according to the accumulation and decay chain are described and analyzed. (R.V.J.)

36705 (NP-15146) GAMMA DOSE RATES FROM GROUND AND STEEL ACTIVATION FOLLOWING NUCLEAR FISSION EXPLOSIONS IN AIR. Bergstroem, A.; Leimdoerfer, M. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Nov. 1964. 25p. Dep.(mn).

A series of calculations was made to display the expected activation gamma dose rate at the air-ground interface induced by neutrons from a nuclear burst in air under different conditions. The removal-diffusion technique was used for the neutron slowing-down calculation. The nuclear explosive was surrounded by varying effective thicknesses of the remainder of the initiating explosive (TNT), ranging from 0 to 50 cm. The burst altitude as well as the ground water contents were also varied, the former from 100 to 1500 m and the latter from 0 to 50 percent by weight. The results are split up to give separately the dose rate contributions from activated Na, Mn, and Al nuclei. Thermal neutron fluxes are also presented for a number of illustrative cases. A supplementary calculation was made to analyse the gamma dose rate contributions from a steel slab on the ground. (auth)

36706 (NP-15181) FIRE BEHAVIOR, IGNITION TO FLASHOVER. Summary of Research Report. Vodvarka, F. J.; Waterman, T. E. (IIT Research Inst., Chicago, Ill.). June 1965. Contract OCD-PS-64-50. 60p.

An experimental program was conducted on the fire buildup resulting from flaming ignitions of major furniture items in simulated residential rooms. Times were determined for the fires to develop beyond elementary extinguishment techniques, and for flashover to occur. The data provide information for determining personnel requirements for civil defense firefighting teams and brigades. In rooms with conventional upholstery, in rooms with foam rubber upholstery, and in bedrooms with box springs, 90% of the fires developed beyond self-help extinguishment capabilities in 26, 8, and 12 minutes, respectively. Bedrooms with open-spring beds did not flash over. (auth)

36707 (NP-15266) DEVELOPMENTS IN PROTECTIVE SHELTER SYSTEMS. Rush, P. J. (Naval Civil Engineering Lab., Port Hueneme, Calif.). Apr. 1965. 129p. CFSTI.

Information is presented on protective and environmental aspects as they apply to design, construction, and operation of shelter systems for the survival of personnel and equipment. More than 400 references were studied to compile the report. Certain of the information was obtained from observations of nuclear detonations and their effects upon various components of shelter systems; other data included are the results of laboratory experiments. Some conclusions were derived from analytical considerations. (auth)

36708 (NYO-3273-5) SURVEY OF RADIOACTIVE CONTENT OF FOOD GROWN ON BRAZILIAN AREAS OF HIGH NATURAL RADIOACTIVITY. Penna Franca, E.; Costa Ribeire, C.; Teitakowski, M.; Londres, H.; Santos, P. L.; Albuquerque, H. A. (Brazil Univ., Rio de Janeiro. Instituto de Biofisica). [1965]. Contract AT(30-1)-3273. 15p. (CONF-650523-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Symposium on Radiation and Terrestrial Ecosystems, Richland, Wash.

Two types of high background regions in Brazil, the monazite sand region along the Atlantic coast and the zone of volcanic intrusives in the inland state of Minas Gerais, were studied. In both regions, there are groups of the population living on variable fields of radiation ranging from 0.03 to 1.0 mR/h. The most representative towns and villages of these areas are being intensively studied in order to investigate possible long-term consequences to human beings of continuous exposure to these levels of radiation. Food produced on the areas have been extensively sampled and assayed for their radioactive content. Total alpha counting, fast alpha pair coincidence counting, radiochemical analysis of ^{226}Ra, ^{228}Ra, and ^{228}Th, as well as gamma and alpha spectrometry have been employed. Data are tabulated. (19 references.) (auth)

36709 (ORNL-P-1034) SAMPLING DEVICES USED IN NUCLEAR SAFETY PILOT PLANT. Holz, Peter P.; Row, Thomas H. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 7p. (CONF-650602-10). Dep. mn; CFSTI, $1.00, cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

The Nuclear Safety Pilot Plant is a facility for studying the transport behavior of fission products in a simulated containment vessel. Sampling devices are provided for determining the distribution of the released fission products. A description is given of the original sampling equipment, and the evolution of five new devices for more detailed analysis is discussed. (D.L.C.)

36710 (RL-SA-3682) FACTORS CONCERNING THE USE OF VENTILATED CLOTHING FOR PREVENTION OF HEAT STRAIN. Wisehart, D. E.; Adley, F. E.; Gill, W. E.; Anderson, D. E. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Aug. 20, 1964. Contract AT(45-1)-1350. 20p. (CONF-652-3). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Industrial Hygiene Association Pacific Northwest Section Meeting, Richland, Wash. Aug. 1964.

Methods of controlling environmental heat stress in industrial areas are reviewed, with emphasis on areas containing radioactive contamination. Factors influencing body heat balance are discussed and equations are included for use in calculating body heat balance. The use of ventilated protective clothing for the prevention of heat strain is described and design and test data are included for several types of protective clothing with and without incorporated ventilation and cooling systems. (C.H.)

36711 (RL-SEP-466) SUPPLEMENTAL CRITICAL MASS AND CHEMICAL HAZARDS CONTROL SPECIFICATIONS HANDLING AND STORAGE OF SHIPPINGPORT REACTOR BLANKET FUEL AT T PLANT. Hanson, G. L.; Rathvon, H. C. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Apr. 26, 1965. Contract AT(45-1)-1350. 4p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Shippingport PWR blanket fuel elements are Zircaloy-clad natural UO_2 assemblies having a length of about 9 ft and a square cross section about 5.5 in. on a side. Specifications for control of criticality and chemical hazards during storage and reprocessing of irradiated elements of this type in the Hanford T plant are outlined. (T.F.H.)

36712 RADIATION PROTECTION PROGRAM FOR A 10-Mev LINEAR ACCELERATOR. Bozich, Thomas A. (Air Force Hospital, Hill AFB, Utah). Am. Ind. Hyg. Assoc. J., 26: 311-17(May-June 1965).

The procedures adopted in establishing a radiation protection program for a 10-Mev linear accelerator employed for industrial radiography are described. The program included calculation of the facility modifications required to provide adequate biological shielding, as well as a complete survey after the modifications were accomplished to ensure their adequacy. The average effective energy of the x-radiation at various areas was also determined. (auth)

36713 DETERMINING INDUSTRIAL HYGIENE REQUIREMENTS FOR INSTALLATIONS USING RADIOACTIVE MATERIALS. Brodsky, Allen (Univ. of Pittsburgh). Am. Ind. Hyg. Assoc. J., 26: 294-310(May-June 1965).

A set of guidelines is proposed as an aid in determining the specific facilities, equipment, and procedures required for operations involving radioactive material. The guidelines are centered around a tabulation that groups the commonly used radionuclides into eight groups corresponding to the relative magnitudes of their maximum radiotoxicities, and then presents curie quantities above which the need for various safeguards should be examined. The eight groups of radiotoxicity are chosen to correspond to the eight orders of magnitude over which the estimated maximum doses per curie range for the various nuclides when they are delivered in a single intake by inhalation. (auth)

36714 A SERVICEABLE IRRADIATOR-SHIELD DEVICE. Smith, T. L. (Coll. of the Ozarks, Clarksville, Ark.). Ann. Entomol. Soc. Am., 58: 245-7(Mar. 1965).

The construction of a radioisotope storage chamber is described and illustrated. The particular chamber referred to was used as a ^{60}Co source for irradiating insects. It can be made in any machine shop at very low cost. The user of the device is completely protected from radiation leakage. It consists of two ends of an ordinary, 14-in. dia gas tank, with a band of sheet metal, 4½ in. wide and of the same thickness as the ends, welded between them to provide appropriate lateral dimensions. The subspherical, sheet-metal tank thus formed was welded to heavy metal footings. Horizontally, through the center of this tank, was placed a 2-in. (ID) tube, open at both ends, which was welded at each end to the hemispheric ends of the tank. A 5-in. section of the upper half of this tube was cut out at its midpoint. To this cut-out area was welded an inverted, somewhat flattened cone. Molten lead (~850 lb) was poured until the empty space within the device was completely filled. A 2-in. (OD) servicing shaft, 25 in. long, was designed which fitted exactly into the 2-in. (ID) horizontal tube running through the device. The shaft was so designed that, when shoved into the closed position, the empty, troughlike part of the servicing shaft was exactly under the large end of the previously mentioned cone. A source holder for holding the radioactive material was made from a piece of 1-in. (OD) tubing with an enlarged outer end. This was filled with lead, except for ½ in. of its inner end. To this inner end the suppliers of the source material attached a doubly sealed capsule of ^{60}Co. This source holder fitted into the open end of the 1-in. tube. A hinged cap with a device for padlocking was welded above the source holder. A check showed that radiation leakage was well within allowable limits. The device is housed in a masonry-constructed vault whose walls provide added protection from any possible leakage from the source material. The design of this device is such that it may be used with complete safety when the servicing shaft is in place. At all times, whether open or closed, there is a plug of lead between the source material and the outside. It can, therefore, be used repeatedly without danger of overexposure to the operator. By inserting a small, electrostatic-ionization-chamber type of dosimeter into the empty, troughlike space in the servicing shaft, and calibrating the emission rate of the isotope, a rate of R/sec value is established. (BBB)

36715 A MECHANIZED ENVIRONMENTAL RADIOACTIVITY DATA FILING SYSTEM. Cagnetti, P.; Failla, L.; Lalli, M. G. Comit. Nazl. Energia Nucl., Notiziario, 11: No. 4, 29-33(Apr. 1965). (In Italian)

A description is given of the mechanized system for filing data on beta radioactivity concentrations in the air and fallout, recorded by all Italian stations. (auth)

36716 STATISTICAL TECHNICS FOR QUALITY CONTROL OF ENVIRONMENTAL RADIOASSAY. Rosenstein, Marvin; Goldin, A. S. Health Lab. Sci., 2: 93-102(Apr. 1965).

The function of the analytical Quality Control Service (AQCS) of the Division of Radiological Health (U. S. Public Health Service) is outlined, as well as its introduction of three complementary procedures for quality control purposes: internal duplicate analysis of actual environmental samples; cross-check analysis of natural environmental samples among laboratories; and special analysis of samples in which the actual content of a nuclide is known. The statistics used for examining the data are the range, as a measure of dispersion or precision, and the mean, as a measure of bias, both of which are studied by the application of standard or modified types of control charts. Through these technics, a record of lab performance can be maintained and discrepancies in analytical results within and among laboratories can be revealed. Thus, divergent results can be identified and corrective action instituted. A program of duplicate measurements on a portion of the actual environmental samples plus the maintenance of appropriate records will quickly yield information on a lab's problem areas or will demonstrate the reproducibility of results. This procedure will not indicate whether a constant bias is present in the measurements, but when the results are precise, systematic bias can be uncovered with greater efficiency. To supplement the internal aspects of analytical control, the second procedure investigates the agreement among several independent laboratories. Special samples of natural or synthetic environmental materials, containing known concentrations of the nuclides of interest, are analyzed and the resulting data are compared statistically to the expected nuclide values. The use of control charts for graphical display of mean values and ranges is outlined. To evaluate lab accuracy, first the mean and range values are checked to determine whether they are within the warning levels and control limits. Second, data which yield mean or range values that are not acceptable are further studied by application of an individual chart. In many cases, through these procedures, unacceptable data can be determined and traced to either a general or specific cause. (TCO)

36717 REMOVAL OF RADIOACTIVE CONTAMINANTS FROM A SEMINATURAL WATER SOURCE WITH U. S. ARMY WATER PURIFICATION EQUIPMENT. Lindsten, D. C. (Army Engineer Research and Development Labs., Fort Belvoir, Va.); Hasuike, S. K.; Friend, A. G. Health Phys., 11: 723-30(Aug. 1965).

Using water dosed five months previously for a pond experiment with ^{137}Cs, ^{60}Co, ^{87}Sr, and ^{65}Zn, mobile U. S. Army water purification equipment was tested for its ability to remove these specific radionuclides. The equipment consisted of a mobile unit comprising an upflow clarifier and a

diatomaceous silica filter plus cation and anion exchange columns in series. The results showed that, for a semi-natural pond contaminated with ^{137}Cs, ^{60}Co, ^{85}Sr, and ^{65}Zn, the removals were 84, 85, 99 and 91 per cent, respectively. (auth)

36718 BACKGROUND URINARY URANIUM LEVELS IN HUMANS. Wing, J. F. (National Lead Co. of Ohio, Cincinnati). Health Phys., 11: 731-5(Aug. 1965). (NLCO-907)

A search was made for an industrially accepted technique for determining the urinary uranium level that best represented non-occupationally exposed persons. A review of the open literature was made and seven values were found giving a wide range of values for non-exposed urinary uranium levels (0.000012 mg uranium/l of urine to 0.026 mg/l). Almost all of these values were developed either by analytical procedures that were criticized, by analytical procedures that are not amenable to industrial application by sampling only a very small number of people. In an attempt to establish a reliable value, a statistical review was made of 1081 urinary uranium results from pre-employee urine specimens taken at the National Lead Company of Ohio during the 5-year period 1958 to 1962. The individual urinary uranium levels, as determined by an analytical method generally accepted for industrial application, are shown to vary over a wide range. The raw data in tabular and graph form and a brief statistical analysis are included. From industrial experience it is concluded that the most representative value for urinary uranium levels from non-occupationally exposed persons lies within the range of 0.005–0.007 mg/l. (auth)

36719 REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTER EVALUATION AND USE AT OAK RIDGE NATIONAL LABORATORY. Baird, J. N. Jr.; Sanford, W. R.; Cristy, G. A. (Oak Ridge National Lab., Tenn.). Health Phys., 11: 743-57(Aug. 1965). (ORNL-P-1249)

The necessity for prudent conservation of potable water, the need for protecting water supplies from contamination, and the increased cost of dual water distribution systems serving an expanding nuclear complex, generated an interest at Oak Ridge National Laboratory in the reduced pressure principle backflow preventer (RPPBP). This device, despite its advantages of economy and convenience, has been only partially accepted as a substitute for air-gap separation in preventing pollution of potable water. Previous tests generally reported dynamic or maltreatment conditions. To provide additional assurance of the safety of the device, a reduced pressure principle backflow preventer was tested under five different static conditions. A solution of manganese and potassium nitrates was used as a nonradioactive tracer. Activation and radiochemical analyses having a sensitivity of ~0.2 parts per billion of manganese proved there was no detectable backflow from the discharge side to the supply side. Potassium analyses also showed no detectable backflow, but with a lesser sensitivity. The Protection Factor (P.F.) for the device is defined as: P.F. = reagent concentration in the discharge zone/reagent concentration in the supply zone due to backflow. The minimum protection factor proved in these tests based upon the limit of the sensitivity of manganese analysis is 6.5×10^8. This factor provides a rational basis for installation where the concentration of radioactivity or other contaminant can be estimated, measured or limited. Criteria for RPPBP installations at ORNL include purchase specifications, inspection requirements, approvals required for use in three levels of hazard, installation requirements and maintenance considerations. (auth)

36720 STANDARDS OF RADIOACTIVITY. Campion, P. J.; Williams, A. (National Physical Lab., Teddington, Middx., Eng.). Health Phys., 11: 769-72(Aug. 1965).

It is important that the certificates which accompany standards of radioactivity should contain as much of the relevant data as possible. The information that a supplier can reasonably be expected to give is discussed and illustrated by reference to the concepts used at the National Physical Laboratory. (auth)

36721 ABSORBED DOSE VERSUS KERMA. Rossi, Harald H. (Columbia Univ., N. Y.). Health Phys., 11: 779-80(Aug. 1965).

Terminology used in radiation dosimetry is discussed in an effort to clarify objectives of radiation measurement. Absorbed dose is defined as the energy imparted by charged particles per unit mass of material at the point of interest. Tissue dose is expressed in terms of kerma (the sum of the initial kinetic energies of all charged particles liberated by indirectly ionizing particles per unit mass of a specified material) to account for the fact that radiation equilibrium never occurs except in an infinite medium containing a uniform concentration of an emitter of indirectly ionizing particles and the fact that in free air measurements it is the intent to characterize the radiation field in terms of its potential interaction with a specified material. (H.G.D.)

36722 "IN PLACE" TEST OF THE AIR CLEANING EFFICIENCY OF A BANK OF HIGH EFFICIENCY FILTERS. Breslin, A. J. (Atomic Energy Commission, New York). Health Phys., 11: 785(Aug. 1965).

An in-place test of the air cleaning efficiency of a bank of high efficiency filters was performed in circumstances that precluded the use of the conventional DOP aerosol and a light-scattering photometer. The method described has possible application where DOP test equipment is not available. It would either identify very poor filter installation or indicate that efficiencies are better than resolution of the technique. (H.G.D.)

36723 RADIOACTIVE FALLOUT IN EXETER SLUDGES. Garry, J. A. (Exeter Sewage Works, Eng.). Inst. Sewage Purif., J. Proc., Pt. 2: 159-61(1965).

Data are provided on the γ activity of concentrated, dried, and ashed sewage samples examined at various periods, particularly in 1962. The Exeter sewage works comprise detritus tanks, screens, sedimentation tanks, and surface-aeration activated sludge units. Surplus activated sludge is returned to the inlet of the primary tanks, which are of 833,000-gal capacity. The rate of flow to the activated-sludge plant is constant at about 2 Mgal/day. In 1957 a local hospital applied for permission to discharge radioactive materials into the public sewer. At that time no information was available on the amount of radioactivity in the Exeter sewage so samples of ashed primary sludge were analyzed for γ activity using a scintillation counter. No significant activity was found until January 1962, when there was a measurable amount. Identification of the isotopes established that most of the activity was from fallout from atomic weapons testing. There were considerable variations in the γ count of the ashed primary sludge due to varying amounts of surplus activated sludge being present. The activated sludge contained the highest radioactivity (up to 6821 counts/g dry matter/1000 sec) and the solid phase carried most of the γ emitters. The concentration of radioactivity was found to be dependent upon rainfall. Samples also were obtained from a variety of other places in England for comparison and the γ counts are given. The highest figure (633 counts/1/1000 sec) was presumed to be due to spray contamination from aeration units. A sample of ashed primary sludge was kept for 15 months and a decay count was made at intervals. The count rate fell from 2180 counts/g ash/1000 sec in Jan. 1962, to 100 in Apr. 1963. This shows that the short-lived materials contributed less activity with time. It was concluded that the concentration of radioactive fallout in this surface-aeration activated-sludge plant showed a close correlation with rainfall. (BBB)

36724 ARTIFICIAL RADIOACTIVITY IN THE PACIFIC OCEAN. Miyake, Yasuo. Intern. Union Geodesy Geophys., Monograph No. 20, 21-30[1963].

Measurements were made on the gross β activity, ^{90}Sr, and ^{137}Cs contents in the North Pacific Ocean. The procedures for radiochemical analyses of ^{90}Sr and ^{137}Cs in sea water are described. Data are tabulated. (P.C.H.)

36725 WATER AND OSMOTIC ECONOMY ON SURVIVAL RATIONS. Johnson, Robert E. (Univ. of Illinois, Urbana). J. Am. Dietet. Assoc., 45: 124-9(Aug. 1964).

The results of simulated fallout shelter tests during which three groups of volunteers consumed the survival rations designed to be used in the shelters during a thermonuclear attack, are reported. Emphasis is given to the effect of these rations on water balance. It is pointed out that water and osmotic balance are mutually related; an osmotic deficit leads to a water deficit because the kidney's ability to retain water is diminished. An osmotic plethora leads to a water deficit through osmotic diuresis, an obligatory loss of water to remove excess osmotically active substances. These considerations must be taken into account in providing water and food for survival. The questions of prime importance are water, total calories, osmotic intake, nonketogenicity, and nontoxicity. Even the best survival ration can only slow down functional deterioration; it can not prevent it. A poorly conceived survival ration is worse than starvation because it can lead to clinical syndromes, such as orthostatic hypotension, dehydration exhaustion, anhidrosis, and renal dysfunction. The same survival ration can be used in all environments. Under identical conditions of environment, physical work, water supply, and diet, there is large inter-individual variability, but a consistent intra-individual pattern in the water economy. Water sufficient to maintain a positive water balance for one person will not necessarily suffice for another. The imposition of a progressively increasing water deficit is not necessarily accompanied by a quantitatively appropriate thirst response. Heat, exercise, and a water deficit all affect the drinking pattern. After severe conditions, a water deficit may not be repaid in 8 hr of recovery. Only after a severe water deficit of 2.5 l or more is there a diminution in the rate of sweating under given conditions. This diminution is not large, only about 50 ml/hr when the total rate is 500 ml/hr or over. Periods of physical work and water deficit do not lead to an improved water balance; i.e., one cannot be trained to get along with decreasing amounts of water. This is contrary to a concept of some military officers who believe that such training is possible. This assumption may lead to heat prostration or even fatal heat stroke. (BBB)

36726 RADIOACTIVITY AND SEWAGE TREATMENT. Lewin, V. H. J. Proc. Inst. Sewage Purif., Part 2: 166-70 (1965).

Some problems in monitoring radioactivity in sewage are examined with reference to results obtained at the Oxford (England) Sewage Works, and some data reflecting radionuclides originating in sewage from fallout and hospital effluents are provided. For hospital effluents the limits considered safe at Oxford were a max of 10 mC per day of radionuclides with half lives less than 14 days but including ^{14}C and ^{3}H and 1 mC of nuclides with half lives more than 14 days but less than 26 weeks. It is suggested that too much reliance is being placed on dilution in the sewers, particularly as discharges were likely to remain as slugs. Longitudinal mixing may be negligible in the sewerage and sewage-treatment system. In radioassays at the Oxford works, primary sludge, surplus activated sludge, and vacuum-filtered mixed digested sludge were dried and examined with a γ-scintillation spectrometer and a 100-channel pulse analyser unit. The results showed that a high proportion of the radioactive material remained in the sludges and that, in addition to materials discharged to the sewers, there were significant quantities of natural fallout products. Iodine-131 was highest in the activated sludge but as it has a half-life of only 8 days, only about 6% was left after 30 days retention in the digestion tanks, as shown by analysis of the filter cake. The γ spectra of the various sludges are shown. The peaks of ^{141}Ce, ^{106}Ru, ^{137}Cs, and ^{95}Zr were more pronounced in the vacuum filter cake than in the primary sludge because the cake contained activated sludge and because of the concentration brought about by the destruction of 56% of the organic solids during digestion. Activity levels were relatively low and it was calculated that if all the sludge from these works were disposed of on 140 acres of land, after 4 yr there would be a 10-fold increase in radioactivity above the average fallout level elsewhere in the district, which was estimated at about 1000 pC/km^2 (256 acres) for all γ emitters at that time. These tests supported the therapy that a considerable proportion of the radioactive material remains in the sludge but that no hazard would accrue from this accumulation in the sludge or its residues on the farm. The quantity of ^{131}I detected was only a fraction of that known to have been discharged locally to the sewers, so tests were made to ascertain its fate. It was demonstrated that if known quantities of ^{131}I were added to activated-sludge mixed liquor and aerated for a few hours, 90% or more was fixed on the sludge. On the other hand, if the proportion of inactive iodide used as a carrier were greatly increased the amount of active material fixed by the solids was reduced. Although at present the levels of fallout are relatively insignificant and radioactivity in waste from medical usage and research work is kept at permissible levels, it is considered that a system of periodic checking and recording should be instituted. (BBB)

36727 ABSORPTION, ENERGY DISTRIBUTION AND BIOLOGICAL EFFECTIVENESS OF NEUTRONS. Hoefert, M. (Institut fuer Biologie der Gesellschaft fuer Strahlenforschung mbH, Munich). Kerntechnik, 7: 262-6(June 1965). (In German)

The nature of the absorption events and thus the local energy distribution is determined by the neutron energy in question and the atomic composition in tissue. The greater biological efficiency of neutrons compared to x and γ rays or electron beams using the same macrogeometrical energy dose is primarily explained by the different microgeometrical dose distribution. In practical radiation protection work the greater hazards in an exposure to densely ionizing radiation are met by different quality factors. (auth)

36728 ADVANCED METHODS IN NEUTRON PERSONNEL DOSIMETRY. Becker, K. (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 7: 274-8(June 1965). (In German)

After an introductory survey on the situation of neutron personnel dosimetry, which is quite unsatisfactory at present, the advantages and disadvantages of several new techniques are discussed which are in some respects better than conventional methods, above all non-photographic nuclear emulsion techniques, silicon diodes, special photographic or ionometric devices, thermoluminescence dosimeters, and radiophotoluminescence (glass) dosimeters. However, none of these systems can fulfill the necessary requirements. The relatively best results follow from combinations of different methods fitting the measuring problem in question. Further developing processes and a very critical weighting of the obtained personnel doses are indispensable. (auth)

36729 MEASUREMENT OF NEUTRON DOSE UNDER THE CONDITIONS OF AN ACCIDENT. Piesch, E. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 7: 279-84(June 1965). (In German)

The measurement of neutron dose immediately after a criticality accident is absolutely necessary for direct radiation protection in case of an unforeseen catastrophe. The personal radiation dose to be expected is estimated by means of dose measurement results; as example accidents or various critical arrangements are treated. A description is given of operation and sensitivity of activation methods determining the personal dose by means of measurement of neutron flux. It is shown that only under special measuring conditions (e.g., a belt of dosimeters) a personal dose as result of neutron and gamma radiation can be determined immediately after an accident with an accuracy of about ±20%. For accidental dosimetry, however, the above mentioned accuracy for the determination of personal dose is absolutely necessary. (auth)

36730 TRANSPORTING RADIOACTIVE MATERIAL. Wilson, E. J. New Scientist, 126: 522-3(May 20, 1965).

New international regulations on safety precautions that form the basis of national regulations for radioactive consignments by land, sea, and air are discussed. Factors

considered in drafting the new standards were: containment, shielding, criticality, and heat emission. (H.G.D.)

36731 AN ELECTRIC ANALOG COMPUTER FOR NUCLEAR FUEL SHIPPING CASK FIRE TESTS. Bonilla, C. F. (Columbia Univ., New York). Nucl. Struct. Eng., 2: 40-7(July 1965).

An electrical analog network for the thermal analysis of nuclear fuel shipping casks under fire accident conditions is described. The network allows the thermal behavior of a wide range of cask dimensions for any given fire temperature curve to be simulated. Changes in thermal properties of the materials involved, melting of the lead shield, and any changes in the heat transfer coefficients during the fire may all be represented. (auth)

36732 FALLOUT SAMPLING METHOD. Gorberg, Zofia; Zarnowiecki, Krzysztof (Inst. of Nuclear Research, Warsaw). Nukleonika, 10: 60-1(1965). (In Polish)

Two methods of fallout sampling were tested. One of the methods utilized the standard liquid bed (distilled water in summer with added alcohol in winter) at the bottom of the plastic sampling vessels and the other utilized a dry bed. The vessels were located 1.5 meters above ground and were emptied daily. The dry bed was flushed daily with distilled water. In 200 tests conducted with vessels of 0.1 square meter area of the opening, the ratio of wet to dry vessel readings varied by over an order of magnitude from test to test, but the average activation collected by the wet vessel was only 3% higher than the dry vessel. This means that very little of the dry-bed activity was blown away by breezes or winds with the design of vessel used. It was concluded that larger vessels of say 0.5 square meter area of the opening are desirable so that the counting statistics are more reasonable. Both innovations result in considerable economies in fallout sampling. The intervals between collection of the fallout samplings can be greatly increased, except soon after a nuclear explosion when the radioactive fallout consists of an appreciable fraction of shortlived fallout debris. (TTT)

36733 RELATIVE AVAILABILITY OF STRONTIUM IN FLOUR AND MILK. Carr, T. E. F.; Harrison, G. E.; Loutit, J. F.; Sutton, Alice (Radiobiological Research Unit, Harwell, Berks, Eng.). Proc. Nutr. Soc. (Engl.-Scot.), 24: 120-6(1965).

Strontium absorption in the gastrointestinal tract was studied in five male human volunteers fed diets mainly composed of bread and milk containing elevated levels of Sr radioisotopes. The experimental flour contained about ten times as much ^{90}Sr as current British flour, and the milk was obtained from a cow given a parenteral dose of ^{85}Sr. Both radioactive markers were therefore biologically incorporated. Urine and feces were collected daily and blood samples were taken from the subjects at intervals. For the five subjects, the mean relative availability was 0.94. The availability to man of Sr from flour, and possibly from other plant sources as well, is equal to that from milk in a mixed diet. The Sr in milk is fully available, but in a mixed diet the availability of Sr may well be determined by the overall constitution of the diet. Thus, phytates which are known to lower the availability of many minerals also lower the availability of Sr, so that cereal-rich diets are likely to have the lowest availability of Sr. The concentration of ^{85}Sr in plasma, and consequently the daily output in urine, increased relatively rapidly for about 7 to 10 days and thereafter increased much more slowly. The rapid rise in the concentration of the radioactive marker in plasma during the 1st week is ascribed to a tendency toward a relatively rapid equilibration between the diet and the body fluids. For bone-seeking tracers, such as Sr, a much slower process of equilibration takes place between the bone and diet. Thus, the tendency toward the relatively rapid radioactive equilibration between body fluids and the diet was modified by the transfer of radioactive ^{85}Sr from blood to bone and the return of inactive Sr from bone to blood. Since body stores of Sr, like those of Ca, are localized in bone, the latter process involves exchange of radioactive Sr and stable Sr between two body compartments represented by the body fluids on the one hand and the much larger bone compartment on the other. There were relatively large variations in the daily urinary output of ^{85}Sr even after 3 or 4 weeks on the diet, sometimes as much as 30%. After the 1st week on the diet, for a given subject, the weekly output of ^{85}Sr in urine differed by only a few percentage units. The cause of this daily variation in the urinary output is uncertain. The mean sp act. of Sr in the diet was about twice that in the urine for all subjects. From the relatively low sp act. of Sr in urine compared with that in the diet and the relatively slow change with time of the former, it is concluded that full body equilibrium would only be achieved in a much longer time. Neglect of this long-term effect on the equilibrium between the various body compartments, especially with bone-seeking tracers, may lead to erroneous conclusions in short-term experiments. (BBB)

36734 THE DETERMINATION OF FACTORS FOR PRODUCING COMPENSATING FILTERS. Zamecnik, J.; Tietze, D. (Onkologischen Institut, Prague and Karl-Marx-Universitaet, Leipzig). Radiobiol. Radiotherap., 6: 367-70(1965). (In German)

With high energy radiation, the layer required for compensating the dose rate must be so far from the surface that the build-up effect is perfect again. The necessary thickness of the compensating layer is smaller than that to be compensated as the scattering portion must be replaced by a smaller absorbing portion. Compensation with 0.55 mm of lead per 1 cm of tissue is sufficient. (auth)

36735 NEW RESULTS IN THE DETERMINATION OF DOSE DISTRIBUTION BY MEANS OF COMPUTERS. Richter, J.; Schirrmeister, D. (Institut fuer Krebsforschung der Deutschen Akademie der Wissenschaften, Berlin). Radiobiol. Radiotherap., 6: 371-5(1965). (In German)

The present calculating program is summarized, and possibilities for increasing the accuracy of isodose determination are given. A method is described by means of which the marginal drop within the radiation field and the scattering outside the radiation field may be taken into consideration. The dose calculated for the central ray is multiplied with a factor that depends on the distance of the point from the central ray and from the half width of the field. This factor is applicable to all field sizes. Some examples demonstrate the isodoses determined by the new method. (auth)

36736 COSMIC RAYS—DO THEY REPRESENT A RADIOBIOLOGICAL HAZARD BETWEEN 20 AND 30 KILOMETERS. Delahaye, R. P.; Tabusse, E. Rev. Med. Aeron. (Paris), 3: 581-4(Jan.-Feb. 1964). (In French)

Cosmic rays encountered at an altitude of 20 to 30 kilometers are galactic or solar in origin. The former are not intense enough to be hazardous. The latter, released at the time of solar eruptions, are usually quickly absorbed by the upper atmosphere or attracted by the earth's magnetic field. Neither type of ionizing is intense enough to cause somatic effects, and probably too weak to be carcinogenic. (Aerospace Med., 36: (Jan. 1965))

36737 THE 2,350 CURIE COBALT-60 THERAPY UNIT IN THE KARL BREMER HOSPITAL. van der Merwe, E. J. (Karl Bremer Hospital, Bellville, Ont.). S. African J. Radiol., 3: 9-12(Apr. 3, 1965). (In Dutch)

The construction and function of the Theratron B unit is described, and the dose rate inside and outside the treatment room are given. The determination of the field factor and the wedge factor in a Mix-D phantom is described, and examples of the isodose curves of ordinary and wedge fields, as measured in the Mix-D phantom with a Baldwin Farmer substandard dose-meter, are given. (auth)

36738 RADIUM CONTENT OF TOBACCO ASH. Chatterjee, Rama Krishna; Banerji, Partha; Ghosh, N. N.; Chatterjee, S. D. (Jadavpur Univ., Calcutta). Sci. Cult. (Calcutta), 31: 188-9(Apr. 1965).

The radium content of indigenous pipe tobacco was determined. The method used is described. It was found that

the activity/g of tobacco ash was lower in the case of Indian brand as compared to its Australian counterpart. This may be due partly to the fact that the contributions to the total activity by α-emitting daughter nuclides of ^{223}Ra and ^{224}Ra were practically eliminated in the method described for the Indian brand. (P.C.H.)

36739 THE EFFECT OF NUCLEAR WEAPON ATTACKS ON DENSELY POPULATED AREAS. Steenbeck, M. (Deutsche Akademie der Wissenschaften zu Berlin). Sci. World, 8: 18-22(1964).

Attempts were made to estimate the effects of various types of nuclear weapons (tactical to megaton strength) on cities in different attack situations. Several examples are provided to illustrate some possible situations. Thus, in a theoretical battle, lasting only a few days, in which three NATO army corps took part and in which 500 to 1000 nuclear strikes were made in an area of 25,000 km^2, the total explosive forces was equivalent to 20 to 25 Mton. The example showed that there was an average of 50 kton distributed over ~ 50 km^2. However, these figures convey only a general view of the mean value of the distribution of the nuclear explosions in the region under consideration. In a discussion of the radiation effects, the initial radiation and the residual radiation are considered separately. Distribution of the dose caused by the initial radiation for the two examples of atmospheric explosion dealt with above is estimated. In an area of more than 60 km^2 the death of 50% of all unprotected inhabitants exposed to the initial radiation of a 50 Mton weapon must be expected. The relation of these projected figures to civil defense problems and to genetic damage is also considered. (TCO)

36740 STRAHLENSCHUTZMESSTECHNIK. (Radiation Protection Measurement Techniques). Kiefer, Hans; Maushart, Rupprecht. Karlsruhe, Ger., Verlag G. Braun, 1964. 611p.

The data on and methods of radiation protection described in the literature were compiled to provide accessible and tabulated information in this field. Dose measurement methods, activity measurement methods, methods for nuclide determination, and the measurement methods used in the protection of the general population are given. Special methods used for individual, hard-to-detect isotopes and the latest developments of semiconductor detectors and radiation measurement problems in space flight are also discussed. (J.S.R.)

36741 AIR CONDITIONED LIVING IN PLASTIC. Frey, A. J. (Hydro-Electric Power Commission of Ontario, Toronto). Toronto, Canadian Nuclear Association, 1965, Preprint No. 65-CNA-207, 17p. (CONF-650515-9). ORINS

From International Conference and Exhibition of Canadian Nuclear Assn., Quebec.

An air conditioning system for plastic protective suits is described. The system was developed to provide suit ventilation for persons working in tritium contaminated atmospheres. A clear face shield eliminates the necessity for using respirators with the suits. (C.H.)

36742 SAFETY OF RADIOISOTOPES IN INDUSTRY. Booth, A. H. (Dept. of National Health and Welfare, Ottawa). Toronto, Canadian Nuclear Association, 1965, Preprint No. 65-CNA-206-11p. (CONF-650515-16). ORINS

From International Conference and Exhibition of Canadian Nuclear Assn., Quebec.

Although potentially, the application of radioisotopes in industry involves a risk of accidents, just as with any other toxic substance, in practice it has been found that such accidents are extremely rare. The reasons for this are the high degree of public interest in radiation and awareness of the hazard, the safety features incorporated by manufacturers in the design of radioisotope devices, the comprehensive and effective regulatory controls established by government agencies, and the back-up services provided by health departments. It is suggested that the safety record of radioisotope uses in industry can be held up as a showpiece in the general field of industrial safety. It indicates what can be done to minimize accidents when the four factors mentioned above combine effectively. (auth)

36743 NPC OBJECTIVES FOR DRINKING WATER CONTAMINATED BY CERTAIN URANIUM–THORIUM–DAUGHTER MIXTURES. Leppard, L. B. (Ontario Dept. of Health). Toronto, Canadian Nuclear Association, 1965, Preprint No. 65-CNA-209, 8p. (CONF-650515-8). ORINS

From International Conference and Exhibition of Canadian Nuclear Assn., Quebec.

It is pointed out that radiological pollution of waters from mill tailings in the uranium mining areas of Ontario has, in the past, been depicted almost exclusively in terms of radium-226 concentrations. While this radioisotope is undoubtedly the most important, we should not set the final objectives for radiological water quality in complete disregard of the marginal effect of others. Six of these others have been picked out as being worth further study, and some general arguments have been advanced in support. Thorium may be the most important extra in the Elliot Lake area waters, and it is particularly noted that this is not natural thorium as defined by the ICRP but a composite having, in gravimetric terms, a considerably lower mpc. We have used for purposes of argument the 1959 ICRP population mpc values without prejudice to any future decision to adopt these or still later ones. On the 1959 basis, the mpc for radium-226 in the affected Elliot Lake area waters would be reduced 10% by the presence of any of the following: 3 pc/l of radium-228; 20 pc/l of lead-210; 90 pc/l (or 0.002 μgm/l of Pa-231; 200 pc/l of Ac-227; and by 140 μgm/l of thorium. (auth)

36744 RADIATION DOSAGE MEASUREMENT OF IRRADIATED MATERIAL. Eukel, Warren W. (to High Voltage Engineering Corp.). U. S. Patent 3,188,469. June 8, 1965. Filed July 16, 1957.

The radiation dosage received by a product or employed in a process can be checked by including with the product in the radiation field a sample of a selected substance in which radioactivity will be induced by the desired amount of irradiation and measuring the radioactivity after exposure. The half life of the induced radioactivity must be less than the time required for the product to reach the consumer. The substance to be used is selected according to the desired level of irradiation; a list of appropriate substances for various levels is included. (A.G.W.)

INSTRUMENTATION

General

Refer also to abstracts 36152 and 36595.

36745 (AD-426242) RESEARCH AND DEVELOPMENT OF AN AUTOMATIC BERYLLIUM-IN-AIR MONITOR. Braman, Robert S. (IIT Research Inst., Chicago, Ill.). [1963]. Contract AF04(611)-7543. 51p. (RTD-TDR-63-1112; IITRI-3203-5). $5.60(CFSTI).

An improved model beryllium-in-air monitor was constructed, calibrated, and tested in the laboratory. Significant improvements include optimization of the air sample system design and elimination of the temperature instability of critical electronic parts. A concentration of 25 micrograms per cubic meter beryllium-in-air requires 4 minutes for reliable alarming, a low level concentration of 2 micrograms beryllium requires 60 minutes. Sensitivity, alarm reliability, and response time are all dependant primarily upon the construction of the alpha source. Other characteristics of the device and instrument design were optimized. (auth)

36746 (AEEW-M-521) DIRECT COUPLED AMPLIFIERS USING FIELD EFFECT TRANSISTORS. Fowler, E. P. (Atomic Energy Establishment, Winfrith (England)). Mar. 1964. 11p. Dep.; BIS, $0.30; HMSO, 1s. 9d.

An application of field effect transistors is presented. The circuit utilizes the combination of low voltage drift and relatively low input leakage current. A pair of field effect transistors in long tail pair connection is directly coupled to a following amplifier which has a balanced input (a transistor long-tail pair), the whole being enclosed in a feedback loop as a virtual earth input amplifier. (M.O.W.)

36747 (CEND-3336-223) DEVELOPMENT AND TESTING OF A TEMPERATURE TRANSIENT METHOD FOR PERFORMING IN-PILE THERMAL CONDUCTANCE TESTING. Progress Report, July 1-September 30, 1964. Burdg, C. E.; Parrette, J. R.; Brockett, R. I.; Chernock, W. P. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Oct. 1964. Contract AT(30-1)-3336. 28p. (EURAEC-1241). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Extensive studies of the transient response of the out-of-pile test system were made, using analog and digital computation methods. These studies provided valuable insight into the effects of several important geometrical and thermal parameters and confirmed the feasibility of performing transient testing to determine fuel element characteristics from clad temperature response alone. In particular, the studies revealed that, for the out-of-pile model, the time-amplitude characteristic of the clad response, i.e., its shape, yields enough information to determine the effective conductivity of the system. The time scale associated with the input pulse and the corresponding clad response is quite convenient from an experimental point of view; pulse lengths on the order of one second, and responses which occur a few seconds later, indicate that sophisticated instrumentation and control may not be needed. Studies of the frequency response of the clad when the input is a sinusoid of variable frequency show that such a technique may make it possible to separate the contributions of fuel conductivity and fuel-clad conductance from the overall effective conductivity of the element. (D.L.C.)

36748 (GEMP-89) CAPACITANCE TEMPERATURE SENSOR. Final Report. Joyce, D. E. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). June 25, 1965. Contract AT(40-1)-2847. 55p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

An investigation of the use of the change of dielectric constant of ceramic capacitance elements as a means of measuring temperature is described. The incorporation of such ceramic elements into two complete temperature measuring systems developed for service in both oxidizing and nonoxidizing atmospheres is discussed. (auth)

36749 (HW-84609(p.7.1-17)) INSTRUMENTATION AND NONDESTRUCTIVE TESTING. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Instrument development for the Pu recycle program is reported. Design of the PRTR fuel rupture monitoring system is described along with neutron flux monitors. Nondestructive testing investigations are described on electromagnetic methods, heat transfer measurement, and ultrasonic methods. Work on metal fatigue detection and ultrasonic imaging is also reported. (J.R.D.)

36750 (LA-DC-6973) DETECTION OF PLUTONIUM PENETRATION THROUGH CONTAINERS AT HIGH TEMPERATURES. Moore, Bill M.; Holm, Dale M.; Ruess, H.; Andelin, R. L. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 4p. (CONF-650602-15) Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

A description is given of a system for monitoring Pu leakage from capsules at 1100°C by counting the alpha particles. The detectors are kept cool by nickel thermal radiation foils. Calibration ^{241}Am sources are located next to the detectors. The analysis of the pulse height distribution for the Pu alpha signal is discussed. (D.L.C.)

36751 (NASA-TM-X-1111) MECHANISM OF FORMATION OF CERTAIN METASTABLE PEAKS NOTED ON A CYCLOIDAL FOCUSING MASS SPECTROMETER. Davies, Myron O. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1965. 7p. (CONF-812-4). CFSTI, $1.00 cy.

From Society for Applied Spectroscopy 3rd National Meeting, Cleveland, Sept.-Oct. 1964.

A previous investigation allowed extended contact between the heated stainless-steel cycloid envelope of the mass spectrometer and gaseous mixtures consisting primarily of hydrogen chloride and water. Because of this contact, roughening of the stainless-steel walls occurred. Backgrounds run with helium showed prominent peaks of definite metastable shape. Similar peaks appeared during procedures for carbiding the tungsten filament. At least eight different metastable peaks were recorded, ranging in mass number from 20 to 260. The metastable peaks are postulated to result from decompositions of iron, chromium, and nickel carbonyls. (auth)

36752 (NASA-TN-D-2787) TWO-PHASE HYDROGEN DENSITY MEASUREMENTS BY THERMAL NEUTRON ATTENUATION. Shook, Donald F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). July 1965. 10p. CFSTI, $1.00 cy.

An experimental evaluation of two-phase hydrogen density measurements by thermal neutron attenuation was made, and the dynamic response to transient-flow situations was determined. Transmission measurements of a polyethylene "mockup" of liquid hydrogen were made, and the beam intensity from many geometric and moderator configurations was determined. The data show that good dynamic measurements can be made with the use of compact polonium-beryllium neutron sources in conjunction with an optimum moderator beam source arrangement. The equipment can be mobile and flexible and can be used to measure the full range of hydrogen mixtures from liquid to gas for a range of pipe diameters. (auth)

36753 (PAEC(A)IN-645) AUTORADIOGRAPHY. A Literature Search. (Philippine Atomic Energy Commission, Manila). Dec. 1964. 61p. Dep. mn.

A total of 292 references is presented under the following headings: general; biology and medicine; chemistry; engineering and equipment; geology, mineralogy, and meteorology; health and safety; instruments and instrumentation; metals, ceramics, and other materials; physics; and reactor technology. The references were taken from NSA for the period Nov. 1950 to Feb. 1964. Corporate and personal author indexes are included. (D.L.C.)

36754 (SC-DC-65-1482) PREPARATION AND COMPILATION OF EXPERIMENTAL DATA FOR COMPUTER ANALYSIS. [Mortley, Jack L.] (Sandia Corp., Albuquerque, N. Mex.). June 1965. Contract AT(29-1)-789. 6p. (CONF-650622-1). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Hydraulics Colloquium, Iowa City, Iowa.

A discussion is given of the techniques and problems encountered in semiautomatic and automatic electronic preparation and compilation of measuring instrument outputs. Criteria are given for deciding whether a situation warrants the use of a Data Link. Typical specifications are given for each of the three storage media-limited systems: punched paper tape and/or card, incremental digital tape, and high-speed digital tape. (D.L.C.)

36755 (SC-R-65-855) TRANSISTOR OSCILLATORS EMPLOYING PIEZOELECTRIC CERAMIC FEEDBACK NETWORKS. Land, C. E. (Sandia Corp., Albuquerque, N. Mex.). Mar. 1965. Contract AT(29-1)-789. 18p. (CONF-650320-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI

From IEEE International Convention, New York.

A technique for using a two or three port ferroelectric ceramic resonant structure as an integrated oscillator feedback network is described. Advantages of an oscillator circuit employing this type of feedback network are discussed. The basic oscillator, equivalent circuits of the feedback networks, a method of measuring the equivalent circuit components, the criteria of oscillation, and characteristics of both fixed frequency and variable frequency oscillators are discussed. (M.O.W.)

36756 (SC-RR-65-185) SYNCHRONIZATION OF A FLASH LAMP AND MASS SPECTROMETER APPARATUS FOR FAST REACTION STUDIES. Freese, James M.; Meyer, Richard T. (Sandia Corp., Albuquerque, N. Mex.). May 1965. Contract AT(29-1)-789. 18p. Dep.(mn); CFSTI, $1.00(cy), 1(mn).

The development of instrumentation for achieving synchronization of events in flash photolysis/time-resolved mass spectrometry experiments is described. A general description of the complete apparatus is provided. In addition, detailed design and operational features of specially constructed synchronizing devices are included. Performance characteristics are discussed in terms of application of the system to a 20-kilocycle spectrometer frequency and a 25-microsecond flash duration. Extension of the apparatus to 100 kilocycles is considered. (auth)

36757 (SC-TM-64-568) A LOW DC CURRENT GENERATOR. Kendall, David R. (Sandia Corp., Albuquerque, N. Mex.). July 1964. Contract AT(29-1)-789. 19p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn

Description of the development of a low d-c current generator used to calibrate various types of micromicroammeters is included. The output current range is 10^{-9} to 10^{-14} amperes with an estimated accuracy of $\pm 1/4$ percent. A linearly increasing voltage function coupled through a high-quality air dielectric capacitor produces a constant output current. The generator utilizes a commercially available operational amplifier and power supply, thus keeping actual construction work to a minimum. (auth)

36758 (SC-TM-65-148) HIGH-POWER DOUBLE-PULSE GENERATOR. Hansen, G. J. (Sandia Lab., Albuquerque, N. Mex.). Apr. 1965. Contract AT(29-1)-789. 9p. Dep.(mn), $1.00(cy), 1(mn) CFSTI.

A pulse generator is developed to provide a high-power double pulse of variable shape. Amplitude is variable from 0 to 1000 volts, pulse width from 0.1 to 100 microseconds, and ratio of first to second pulse amplitude from 0.1 to 1.0. Graphs and equations are determined to allow rapid calculation of pulse forming network component values. (auth)

36759 (TID-21720) DEVELOPMENT OF A HIGH-SPEED PHOTOMULTIPLIER. Progress Report, July 2, 1964–January 2, 1965. Feaster, G. R.; Owen, L. D. (Westinghouse Electric Corp., Elmira, N. Y. Electronic Tube Div.). Contract AT(30-1)-2825. 24p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Two operable tubes were obtained from 31 starts. Low dynode gain and high gas level were the principal production problems, with the latter being the cause of most of the shrinkage. Effort continues toward achieving a tolerable shrinkage figure. A brief summary of progress in the development of high speed photomultiplier is given. (auth)

36760 (TID-21902) A SURVEY AND EVALUATION OF THE SEMICONDUCTOR NOISE LITERATURE. Scientific Report No. 1. Blalock, T. V. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). May 28, 1962. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 51p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

A study and evaluation of the significant literature on semiconductor noise is presented. A survey of the major theoretical work is given, including a derivation of the thermal noise formula developed by H. Nyquist, a development of the full shot noise formula, a review of Van Der Ziel's classic paper on shot noise in transistors, a discussion of a thermodynamic method for quantifying shot noise, and a brief discussion of flicker noise. Transistor noise models and noise generator correlations are reviewed, and figures of merit and noise measurements are discussed. (auth)

36761 (TID-21917) TRIGGER POINT STABILITY OF EMITTER-COUPLED MONOSTABLE MULTIVIBRATORS. Scientific Report No. 4. Coffman, D. W.; Kennedy, E. J.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Jan. 30, 1963. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 51p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

An analysis of the trigger point stability of a monostable emitter-coupled multivibrator is given. The two modes of operation investigated are (1) the first transistor cut off and second transistor saturated initially and (2) the first transistor cut off and second transistor active. An investigation of various methods of triggering the circuit is made. The best place to inject a trigger pulse for both modes of operation is into the first collector. Therefore, an equation relating the amplitude of the trigger pulse to the circuit parameters is derived. Partial derivatives and the equation for the total differential are used to derive expressions for the trigger point as a function of temperature and supply voltage. Circuits to stabilize the trigger point were investigated. Compensated circuits were designed. Experimental and theoretical results are included to indicate the degree of accuracy that may be obtained by using the derived equations. In general, the accuracy is very good. (auth)

36762 (TID-21922) A D-C TO D-C CONVERTER UTILIZING A CERAMIC PIEZOELECTRIC TRANSFORMER. Scientific Report No. 8. Gourse, S. J. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). June 10, 1963. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 44p. Dep.(mn); $2.00 (cy), 1(mn) CFSTI.

The most favorable operating conditions for a high-ratio d-c to d-c converter using a three-terminal piezoelectric transformer driven by a single-transistor oscillator were determined. A preliminary equivalent circuit for the input side of the resonant transformer was determined from the terminal characteristics. While this equivalent circuit was sufficiently accurate for the oscillator design phase, the overall accuracy of this circuit is extremely doubtful because a-c measurements on the output terminals of the transformer were not practical. The input characteristics of the transformer indicated that it should control the operating frequency of the oscillator. Therefore, the crystal was placed in the base-emitter circuit of the transistor. Favorable collector-load conditions for the oscillator were

derived. Experimental data are included on the performance of the final model. (auth)

36763 (TID-21927) A SURVEY AND EVALUATION OF BIAS STABILIZATION TECHNIQUES IN TRANSISTOR CIRCUITS. Scientific Report No. 2. Kennedy, E. J.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). June 29, 1962. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 67p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A survey and evaluation of the literature on bias stabilization in transistor circuits is presented. Original experimental data and ideas are also included. A general introduction to the stability problem is given. The temperature variation of several of the most important transistor parameters is summarized. Linear stabilization concepts are considered, and various nonlinear compensation devices and their use in bias stabilized circuits are studied. Stabilized low power circuits are surveyed briefly. Numerous curves, circuits, and examples are given to illustrate the important facets of bias stabilization. 109 references. (auth)

36764 (TID-21933) A TRANSISTOR HYBRID-PI NOISE MODEL. Scientific Report No. 3. Nutt, Ronald; Bialock, T. V.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Oct. 1, 1962. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 75p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A hybrid pi noise model is developed that has several advantages over Van Der Ziel's low-frequency noise model. First the noise generators in the hybrid pi model have a correlation of almost zero; whereas, in Van Der Ziel's model the correlation is almost unity. In the new model, the noise in the output from each source is independent of the other sources. Another advantage is that the noise voltage in the output is easily calculated. A third and very important advantage is that the new model is valid for the high-frequency range as well as the mid-frequency range. In its simplest form the model is valid to approximately one-tenth of the alpha cut-off frequency, or well above the beta cut-off frequency. Experimental data is included showing that noise voltage predicted by the model for two different transistors agrees remarkable well with measured values. A description of the apparatus used as well as the techniques for measuring the output noise voltage is also included. (auth)

36765 (TID-21936) PROGRESS REPORT ON SUBCONTRACT NO. 2160 FOR THE PERIOD DECEMBER 15, 1961 TO DECEMBER 1, 1962. Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The development of low-noise solid-state amplifiers and of systems for stabilizing d-c voltages produced by solid-state circuits is reviewed. (T.F.H.)

36766 (TID-21939) AN EXPERIMENTAL STUDY OF NOISE IN SILICON PLANAR TRANSISTORS. Scientific Report No. 6. Sabin, A. S.; Bialock, T. V.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Mar. 20, 1963. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 65p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Noise characteristics of typical silicon planar bipolar transistors were obtained experimentally as a function of the following variables: frequency (10 to 300 kc), temperature (−15 to 85°C), emitter current (0 to 700 μa), and generator resistance (0 ohms to 1 megohm). Comparisions are made between the experimental data and the results predicted by a hybrid-pi noise model. When expressed on a noise/(cycle)$^{\frac{1}{2}}$ basis, both output noise and ENV are independent of frequency over the range investigated. In addition, both the output noise and ENV increase with an increase in temperature. When the emitter current is increased, both the output noise and the gain increase by roughly the same factor. Consequently the ENV is relatively constant as I_E changes from 100 to 500 μa. Finally, the output noise increases as R_g increases. The data included should be useful in designing silicon planar bipolar transistor amplifiers with low noise characteristics. The data should also be useful in modifying the hybrid-pi noise model, obtaining better correlation between experimental and theoretical results. (auth)

36767 (TID-21952) AN AUTOMATIC X-RAY DIFFRACTOMETER FOR POLE-FIGURE ANALYSIS OF POLYMER ORIENTATION. ONR Technical Report No. 78. Desper, C. Richard (Massachusetts Univ., Amherst. Polymer Research Inst.) Jan. 15, 1965. Contracts AT-(30-1)-3003-2 and Nonr 3357(01). 90p. Dep.(mn); $3.00 (cy), 2(mn) CFSTI.

An automated x-ray diffractometer was designed and built to obtain pole figure data on polymeric samples. The pole figure goniometer is automatically driven, in a prefixed, constant-increment program, by two pulse motors, allowing the operator to determine the complete distribution pattern for a given h k l plane automatically. The results are punched out on IBM cards; two programs have been written to process this data on the IBM 1620 computer. The first program computes the x-ray intensity at each sample orientation, corrected for absorption, polarization, background, and incoherent scattering. The second program uses this intensity data to obtain locations of constant-intensity contour lines. (auth)

36768 (TID-21971) ANODIZED ZIRCONIUM PHOTOVOLTAIC CELLS (thesis). Ramachandran, Pallassana N. (Tempie Univ., Philadelphia, Pa.). May 1, 1965. Contract AT(30-1)-2775. 104p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Photoeffects occurring in anodized Zr electrodes at room and liquid-N_2 temperatures are studied. The electrodes are of the type $Zr/ZrO_2/M$ and Zr/ZrO_2/gas phase/M, where M is Sn, Bi, Fe, Cu, Ag, Au, Al, Na, Pb, or, in the Zr/ZrO_2/gas phase/M case, M may be Zr. (T.F.H.).

36769 (UCRL-11165) SYNTHESIS OF A TRANSMISSION-LINE RESONATOR WITH A SPECIFIED FREQUENCY SPECTRUM. Large, David B. (Lawrence Radiation Lab., Univ. of California, Berkeley). Dec. 18, 1963. Contract W-7405-eng-48. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An attempt is made to design a resonant section of TEM transmission line such that a high-voltage point corresponds to an open-circuit end, and such that resonance occurs at all integer multiples of some fundamental frequency. The theoretical solution to the problem is presented. (M.O.W.)

36770 (FTD-TT-64-1381) AUTOMATIC Γ FLAW DETECTOR. Dzhabadari, A. V.; Khvedeliani, Ya. R. (and others). Translated from Russian Patent 153,139. July 6, 1961. 5p. CFSTI.

The detector includes a shielded container holding a number of radioactive ampoules which are fastened to the ends of flexible lines. To bring out the ampoules, the lines are wound onto drums by an electric motor. A throwover adaptation device in the form of a lever turned by hand is used to shift a roller axially over the drum to link the motor to the drum. (D.L.C.)

36771 (UCRL-Trans-1194) DESCRIPTION OF THE OPERATION OF A GENERATOR OF HIGH-VOLTAGE NANOSECOND PULSES DEVELOPED AT THE TPI RESEARCH INSTITUTE. Alikhanyan, A. I. Translated by M. Kassatkin (Univ. of California Lawrence Radiation Lab., Berkeley). 1965. 4p. Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.10(fs), $0.80(mf) JCL.

A generator is described that produces pulses having leading edges of 2 nsec, typical durations of 40 nsec, and voltages of 250 to 500 kv, depending on the matching between the coaxial line and the load. The generator is based on the principle of discharge of a noninductive accumulator on a coaxial line. (T.F.H.)

36772 MANIPULATOR SYSTEMS DEVELOPMENT AT ANL. Argonne Natl. Lab. Rev., 2: No. 3, 47-51 (July 1965).

Manipulator systems consist primarily of one or two mechanical working arms located in a hazardous area, a control console or arm and handle located in a safe area, appropriate mechanical or electro-mechanical linkages to couple the controls to the working arms, a viewing device, and on audio device. This integrated system is designed so that the working arms can be controlled by a human operator to perform a wide variety of manipulations on solid objects. Since an object has 6 independent degrees of freedom when it is restricted, the manipulator must be able to grasp the object and apply 3 independent forces and motions and 3 independent couples and rotations to it. These working arms must be able to grasp a wide variety of sizes and shapes of objects and apply a fairly wide range of forces, couples, and motions to them. The arms can be controlled by switches, levers, or by a similar arm located at the operator's station and equipped with a suitable handle. A diagrammatic drawing shows the essential components of a manipulator system and the flow of control and sensory information. Design features of unilateral electric manipulator systems, mechanical master-slave manipulator systems, and electric master-slave manipulator systems are described. The development of improved designs is discussed. (C.H.)

36773 OPTICAL QUANTUM GENERATOR WITH Q-FACTOR MODULATION ON NEODYMIUM GLASS. Basov, N. G.; Zuev, V. S.; Senatskii, Yu. V. (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 1562-4(June 1965). (In Russian).

An optical quantum generator (laser) on neodymium glass is described which emits two light pulses with a total energy of 8 J and pulse duration from 25 to 43 nsec. A method for shortening the time and decreasing the number of pulses is suggested. (auth)

36774 USE OF ARTIFICIAL CURRENT COMMUTATION IN A PARALLEL ION INVERTER OPERATING WITH A RESONANCE CONTOUR. Gusev, O. A. p.76-85 of "Elektrofizicheskaya Apparatura. Vypusk 3." Moscow, Atomizdat, 1965. (In Russian)

Three basic difficulties are encountered in the use of a parallel ion inverter in a resonance circuit: the inverter can not easily be connected to a de-energized circuit; the inverter is unstable for small phase shifts ψ between the current and voltage at the output of the inverter; and the power is proportional to sec ψ, so that only low-power operation is possible in the transition regime. Three circuits are described which use artificial commutation; these circuits allow $\psi = 0$, and avoid the above difficulties. In the first two circuits, one and two auxiliary rectifiers and capacitors are used to stabilize the current. The third circuit uses an additional inductance and is simpler to build, but it is only applicable to frequencies above 50 cps, and is not so easily connected to a de-energized circuit as the other two. The instantaneous power output of all three circuits is on the order of one megawatt. (TTT)

36775 A STUDY OF HOMOGENEOUS CIRCUITS FOR CASCADE VOLTAGE MULTIPLICATION, THE LINKS OF WHICH HAVE THE STRUCTURE OF A BAND FILTER WITH INDUCTION COUPLING. Svin'in, M. P. p.86-98 of "Elektrofizicheskaya Apparatura. Vypusk 3." Moscow, Atomizdat, 1965. (In Russian)

Formulas are presented for the basic quadrupole circuits for cascade connection of separating transformers (with and without rectifiers); for induction coupling of resonance circuits; for the optimum load resistance as a function of the number of cascades in the circuit; of the dependence of the voltage efficiency on the load resistance; and for the effect of changing the frequency on the basic characteristics of an inductively coupled circuit. The formulas are intended for low-frequency circuits for voltage multiplication to 5 Mv. Characteristic curves are presented. (TTT)

36776 AUTOMATIC ADJUSTMENT OF SYNCHRONIZING FREQUENCY STABILIZER FOR MAGNETIC FIELD. Kunstman, V. G.; Tsvetkov, V. N. p.99-105 of "Elektrofizicheskaya Apparatura. Vypusk 3." Moscow, Atomizdat, 1965. (In Russian)

The stabilization of a magnetic field based on the nuclear magnetic resonance (NMR) usually uses a phase detector which reacts to the first harmonic of the signal. Calculations show, however, that if the magnetic field is relatively inhomogeneous, but the required stability is on the order of 10^{-4}, a shift of the loop of the autodine used to stabilize the circuit from the stabilizing frequency also shifts the null-point of the phase detector and causes a nonnegligible error in the tuning. A scheme is presented for automatically tuning the autodine loop by introducing a weakly coupled semiconductor capacitor, which has a variable voltage with a frequency of 3 kc, modulating the tuning frequency of the loop. This leads to a periodic changing of the high-frequency voltage at the loop, the phase of which depends on the sign of the untuning of the loop with respect to the synchronizing frequency. This voltage is detected by the same detector used for the voltage of the NMR signal. Through a filter, this voltage separates the signals which reach the phase detector. The voltage of the phase detector corrects the working bias of the semiconductor capacitor to compensate for the change in the parameters of the autodine loop. If the untuning of the loop is high enough that the voltage at the output of the phase detector exceeds the working voltage of the relay system that operates the motor actuator, the autodine is tuned by a change in the capacity of the loop. Application of this circuit reduces the error in the tuning of the stabilizing circuit by a factor of 10. (TTT)

36777 FIZICHESKAYA ELEKTRONIKA. VYPUSK 2. (Physical Electronics. Issue 2). Zhigarev, A. A. (ed.) Moscow, Atomizdat, 1965. 136p.

Separate abstracts were prepared for seven of the ten papers included. The remaining papers deal with the spectra of glow discharges in Ar and Ne, use of electro-vacuum devices in the laboratory, and studies of semiconductor devices. (D.C.W.)

36778 NEUTRON TIME-OF-FLIGHT MULTICHANNEL ANALYZERS FOR THE LINEAR ACCELERATOR OF THE C.B.N.M. de Keyser, A. (Euratom-Central Bureau for Nuclear Measurements, Geel, Belg.). pp 79-82 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The characteristic features of the different time-of-flight analysis systems are described which will be used for neutron physics work around the electron linear accelerator. Five time-of-flight multichannel analyzers will be at hand which dispose of 4096 channels each and channel widths of 10 nsec minimum. Pulse height and multiparametric analysis is also possible. Three of these analyzers contain a so called accordion-feature which means that inside the time analysis range up to 8 zones of interest with different channel widths can be chosen. For fast time of flight analysis a 1 nsec time coder will be used. (auth)

36779 GENERAL SURVEY: MAGNETIC TAPE DATA RECORDING SYSTEMS. Egelstaff, P. A.; Rae, E. R. (United Kingdom Atomic Energy Research Establishment, Harwell, Berks, Eng.). pp 83-95 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The advantages and disadvantages of the magnetic tape recording systems compared to on-line or paper tape systems are pointed out. An outline of the development and techniques, a typical magnetic tape system is given, followed by a discussion on the use of these systems and future trends. (L.B.S.)

36780 A MAGNETIC TAPE DATA COLLECTION SYSTEM WITH AN INSTRUMENTATION TAPE DECK AND HIGH POSSIBLE STORAGE DENSITY, FOR INFORMATION RATES FROM ALMOST ZERO TO GREATER THAN 20,000 EVENTS PER SECOND. Idzerda, A. B. (Euratom-Central Bureau for Nuclear Measurements, Geel, Belg.). pp 104-9 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A standard instrumentation magnetic tape deck (EMI, 24 tracks on one inch tape, speeds 15/64–120 i.p.s.) has been provided with an additional stepping motor. Having both recording possibilities on one tapedeck–continuous and stepwise tape drive–data can be recorded with high storage density for a wide range of event rates. Special procedures for testing the storage performance together with studies of most suitable error checking methods have shown that standard tape decks can be useful and reliable for collecting data from nuclear experiments for off-line analysis. (auth)

36781 GENERAL SURVEY: FAST ANALOG TO DIGITAL CONVERTERS. Gatti, E. (Centro Informazioni Studi Esperienze and Politecnico, Milan). pp 259-67 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The development and principles of operation of fast analog-to-digital converters–those which have an input stretcher and those which utilize a sampling circuit at the input–are discussed. The technical improvements of components, mainly fast transistors and tunnel diodes, and new methods for achieving satisfactory differential linearity have led to the development of fast converters more suitable for actual needs. (L.B.S.)

36782 GENERAL SURVEY: TIME MEASUREMENTS IN NUCLEAR PHYSICS. Amram, Y. (Centre d'Etudes Nucleaires, Saclay, France). pp 268-90 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A general survey is made of techniques employed in time measurements using electronic systems; in particular, for life time and time-of-flight measurements. Following a review of the improvements in conventional digital multichannel analyzers, descriptions of the main methods in the nanosecond and subnanosecond range, and analysis of their limitations are presented. (L.B.S.)

36783 A ONE NANOSECOND RESOLUTION DIGITAL TIME SORTER. De Lotto, I. (Comitato Nationale delle Ricerche, Milan); Gatti, E.; Vaghi, F. pp 291-9 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

An instrument is described that classifies time intervals in channels whose address is obtained as the difference of two digital evaluations of absolute time corresponding respectively to the beginning and to the end of the time interval to be coded. A unique process of channel width equalization occurs for this kind of instrument when the time intervals are random with respect to absolute time. This process is theoretically examined and experimentally verified. Logical organization of the instrument, circuit details and experimental results are briefly discussed. (auth)

36784 A VERNIER CHRONOMETER. Cresswell, J.; Wilde, P. (Rutherford High Energy Lab., Chilton, Eng.). pp 300-10 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A range of logical circuit elements were developed at the Rutherford Laboratory which are capable of operating at clock frequencies of 400 megapulses per second and capable of producing logical decisions in times of less than one nanosecond. These were used to construct a vernier chronometer which has certain characteristics differing significantly from previous work. Though capable of use in conventional time-of-flight spectroscopy, application was made towards particle identification and spark chamber control for various experiments on NIMROD. The important typical characteristics are: full scale range 50 nanoseconds, determined by available flight paths; channel width 0.5 nanoseconds, determined by the limiting resolution of photomultipliers; and analysis time 100 nanoseconds, determined by the trigger requirements of spark chambers and the high particle fluxes involved. It is this latter characteristic which is so different from previous results and enables the vernier chronometer to be used in a new field of applications. (auth)

36785 A TIME-TO-VOLTAGE CONVERTER FOR HIGH COUNTING RATES. Maeder, D. (Universite, Geneva). pp 311-16 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A type 506 time-voltage converter is described, which accepts standard CLR/A signals (–0.7V/2ns FWHW from 75Ω lines) for start and stop. It transforms a time range $T_{t_{max}}$ into a voltage swing from +5V to –5V. It acts as a d-c coupled stretcher and performs gating functions. In applications with a fast proton beam traversing a scintillation counter telescope, a 1.0 ns (FWHM) time resolution was obtained, at input counting rates exceeding 10^6/s. (L.B.S.)

36786 A FAST BINARY ANALOG TO DIGITAL CONVERTER. Fraenz, K.; Schulz, J. (Telefunken-Forschungsinstitut, Ulm, Ger.). pp 317-22 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A 256 channel analog to digital converter is described, that evaluates pulse height through binary weighting. Integral and differential linearity is better than 1%. Dead time is smaller than 10/μs and independent of pulse height. (auth)

36787 GENERAL SURVEY: ASSOCIATIVE STORAGE FOR NUCLEAR PHYSICS. Hooton, I. N. (United Kingdom Atomic Energy Research Establishment, Harwell, Berks, Eng.). pp 338-48 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964. (AERE-R–4648)

A survey is made of programmed and hardware systems that have been proposed for associative stores. The programmed systems include the sequential method, tree method, multiple tree method, and transformation methods, which make use of conventional stores in association with suitable programs. The store-based and bit-based hardware systems are discussed. The disadvantages of programmed systems are pointed out, and remarks are made on the future commercial development of suitable hardware. (L.B.S.)

36788 AN ASSOCIATIVE STORE FOR NUCLEAR PHYSICS RESEARCH. Hooton, I. N. (United Kingdom Atomic Energy Research Establishment, Harwell, Berks, Eng.). pp 349-56 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A system design is presented for an economically feasible multichannel digital analyzer having the following specification: 10^6 channels, of which the 4000 most probable are analyzed; 65,000 counts, 16-bits, in each stored channel; a mean input rate of 5000 events per second with a resolution between two events of 10 μs; live display as either counts per channel or x, y contours. Associative storage is required since a comparison must be made between each input signal and the store content to find the appropriate channel location. Conventional electronics are envisaged for the content addressable elements, it is therefore essential on economic grounds to limit the number used. Essentially, instead of comparing each input with all channels stored, each stored channel in turn is compared simultaneously with all words in an input buffer. Hence only the buffer need be content addressable. Conventional 4000 words stores can be cycled 40 times faster than the required input rate; the input buffer therefore need only contain 100 words each of 20-bits. The main store is 4096 words of 36-bits, 20-bits for channel number, 16-bits for contents. The system is applicable to other configurations. (auth)

36789 USE OF STANDARD MEMORY SYSTEMS AS ASSOCIATIVE MEMORIES FOR INTEGRATING STORAGE OF MULTIPARAMETER DATA BY AUTOMATIC DATA REDUCTION. Meyer, H.; Stueber, W. (Euratom-Central Bureau for Nuclear Measurements, Geel, Belg.). pp 357-67 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

Memory systems with word capacities in the range C = 4000–16000 and with word dimensions up to N = 40-50 bits are available on the market as standard units. By splitting words with N bits into two parts, A bits for word identification and N-A bits for the integration of words, C different words or addresses of a multiparameter spectrum can be stored out of 2^A possible different words. The peaks of a spectrum will be automatically selected for storage because of their greater probability of first arrival. Therefore they must represent the regions of interest. The necessary type of storage process introduces average processing times (for the storage of one event) up to C/2 times the memory read-write cycle time, and even more (up to C × cycle time) if the partial rate in the non-interesting regions cannot be neglected. Rough manual reduction treatment (with the help of preliminary qualitative analysis before a final experiment) and the use of buffer stores will improve conditions. These are normally not seriously bad with the standard memories now available (read-write cycle times about 2 μsec) and the low information rates in multiparameter experiments. (auth)

36790 SOME THEORETICAL AND PRACTICAL RESULTS OF BUFFER STORAGE SYSTEMS DEVELOPMENT. Stueber, W. (Euratom–Central Bureau for Nuclear Measurements, Geel, Belg.). pp 368-73 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

Considerations of the necessary characteristics of buffer stores for time-of-flight experiments, especially with off-line analysis, are made. Calculations and curves are given for the usefulness and the necessary size of buffer stores in experiments with intense neutron bursts. Two buffer stores, which can be combined, are briefly described, namely a 10-word ferrite-core store with a cycle time of 2 μs and a 3-word tunnel-diode store having a cycle time of 0.1 μs. (auth)

36791 AN ELECTROMAGNETIC ANALOG STORAGE SYSTEM WITH NANOSECOND RESOLUTION. Maeder, D. (Universite, Geneva). pp 379-84 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A dual-input gated linear amplifier is connected to a low-loss cable so that a memory loop (cycle $T_l \sim 10^{-7}$s) is formed when input No. 2 is switched on. Unknown signals enter the cable through input No. 1 (normally "on"), which is turned off when timing system is triggered. Signals that occurred in period T_l preceding the triggering are thus trapped in closed loop for several μs. With present experimental setup, an originally sharp rise is smeared to ~4 ns after 40 regeneration cycles. Possible applications include: single-shot sampling technique for displaying individual nanosecond waveforms on a conventional oscilloscope; temporary storage of a burst of pulses, to permit pulse-height analysis of individual pulses; testing amplifiers and other transmission systems for transient response, linearity, and stability; and digital memory using clock rates up to 200 Mc/s. (auth)

36792 A DIGITAL DATA HANDLING SYSTEM WITH PAPER TAPE OUTPUT. Ashmore, A.; Range, W. H. (London Univ.). pp 444-5 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The system will process data at a maximum rate determined by the paper tape punch. Recording losses are minimized by interposing a derandomizing magnetic core store between the data input and the tape punch. This core store can accept events, having not greater than 16 6-bit characters, at a peak rate of 2×10^4 events per second and will continue to accept data provided that there is a vacancy in the memory for one or more events. Data can be presented to the system in digital or analog form; the latter being digitized prior to transfer into the store. The equipment has processed 5×10^5 events in a p-p polarization measurement at 47.5 Mev at the Rutherford Laboratory. (auth)

36793 SLOW DATA HANDLING WITH SIMPLE MAGNETIC TAPE RECORDERS. Patzelt, R.; Attwenger, W. (Elektronik-Institut, Reaktorzentrum, Seibersdorf, Austria). pp 446-8 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

Plans and preliminary results dealing with a low speed, low density data handling system using very simple magnetic tape machines are described. For a given range of applications high speed systems are too expensive, on the other hand manual work is too slow. Data accumulation at a speed up to 100 words/sec can easily be handled with very simple 2–5 track magnetic tape machines. Processing by simple electro-mechanical adding machines, XY recorders etc. must be done at 1 word/sec, hence a ratio of 100 : 1 between tape speed for recording and replaying is necessary. A typical application is fast read-out from a normal multichannel-analyser and afterwards direct printing from the tape into a serial machine (even summing up of channel groups), XY-plotting etc. Other data handling and program-controlling problems can be handled too, where paper tape is too slow, too expensive or too inconvenient. The problems of optimization of the combination of write and read heads are investigated. (auth)

36794 AUTOMATIC SYSTEM FOR ACQUISITION OF NUCLEAR DATA WITH PAPER TAPE OUTPUT. Sanchez Izquierdo, J.; Tanarro Sanz, A.; Rodriguez Mayquez, E. (Junta de Energia Nuclear, Madrid). pp 458-62 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

In order to collect automatically data from a great number of samples for plotting of neutron flux distribution maps in subcritical or critical assemblies by using activated foils, a complex digital system was designed and built which includes two main parts: an electromechanical device associated to a set of radiation detectors, which allows the activated foils, proper standards and background radiation to be measured according to a previously selected program; an electronic system which counts detector pulses and punches out the data in paper tape, as well as the required instructions to drive an electric type-writer or the input unit of a general purpose computer. The system has worked fully satisfactorily a year and supposes an important step in the automatic acquisition of nuclear data at JEN. (auth)

36795 MICROWAVE TUBES. Proceedings of the 5th International Congress, Paris, September 14-18, 1964. New York, Academic Press, 1965. 567p. $55.00. (CONF-719).

One-hundred-forty papers are included. Low-power tubes are discussed, including low-noise, focusing-system, traveling-wave, cyclotron, oscillator-klystron, and crossed-field tubes. High-power tubes are considered, with discussions of parasitic signals, progressive-wave tubes, electron beams, klystrons, and crossed fields. Studies on beam optics, plasma waves, electron emission, beam-plasma interactions, masers and lasers, and new systems of microwave generation are presented. (M.J.T.)

36796 PULSE GENERATOR. Martin, John Christopher (to United Kingdom Atomic Energy Authority). British Patent 988,778. Apr. 14, 1965. Filed Jan. 12, 1962.

A unit pulse generator circuit includes at least three electrically conducting sheets arranged in spaced parallel relationship to form at least one pair of parallel strip transmission lines, each pair of lines sharing a common sheet. Connections are provided for charging the lines so that the two sheets other than the common sheet have the same polarity relative to the common sheet. Output connections are located at the adjacent ends of the two sheets other than the common sheet, and switching means are provided for short circuiting the end of one of the pairs of lines remote from the output connections. A plurality of these units arranged in spaced parallel relationship and having the outputs connected in series with one another may be used to make up a multiple pulse generator circuit. (B.L.M.)

36797 LUMINOUS SOURCE WHEREIN THE LUMINESCENT MATERIAL IS ACTIVATED BY RADIATION FROM A RADIOACTIVE SOURCE. Mueller, Paul. U. S. Patent 3,176,132. Mar. 30, 1965. Priority date Apr. 20, 1959, Germany.

A luminous source includes a light transmitting housing, a light transmitting carrier retained within the housing, and a luminescent substance supported on the carrier. The carrier means divide the space within the housing into a number of zones that contain radioactive materials. The maximum dimensions of the zones are no greater than the order of magnitude of the transmission range of the utilizable radioactive radiation so that the radiation produced strikes the luminescent substance and causes it to emit light. (B.L.M.)

36798 GAMMA DENSITOMETER FOR TESTING RAILROAD TIES. Wright, James J. (to Cleveland Technical Center, Inc., Cleveland). U. S. Patent 3,176,134. Mar. 30, 1965. Filed Nov. 23, 1960.

An apparatus is described for the nondestructive testing of the structural soundness of the interior of railroad ties or other wood parts from only one surface. The apparatus is mounted on a wheeled vehicle adapted to travel on railroad tracks. The apparatus includes means for emitting gamma rays (less than 1.02 Mev) into the tie and measuring the gamma rays scattered from the interior of the tie to determine the density of the tie and hence its structural soundness. (B.L.M.)

36799 HIGH-DUTY-CYCLE MULTIVIBRATOR. Hale, Duane O. (to U. S. Atomic Energy Commission). U. S. Patent 3,184,604. May 18, 1965. Filed July 31, 1961.

A monostable multivibrator circuit for shaping intermittent pulses from a signal source is designed to minimize dead time and provide more continuous sensitivity to input pulses. The second portion of the multivibrator cycle, which occurs when the resistance-capacitance network is being discharged, is largely eliminated by lowering the resistance of the path through which the capacitance element discharges to a very low value during the second portion of the cycle. This is accomplished by a transistor placed in shunt with the major portion of the resistance in the discharge path of the capacitance element, the transistor being rendered conductive during the latter portion of the operating cycle. Circuit values may be adjusted to limit output pulses to rates that can be handled by following circuits. (A.G.W.)

Radiation Detection

Refer also to abstracts 36149, 36151, 36228, 36229, 36699, 36856, 36928, 36931, 36936, 37787, and 38091.

36800 (AECL-2265) CALIBRATION OF TRITIUM-IN-AIR MONITORS. Banville, B. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1965. 22p. Dep.; $0.50(AECL).

A method primarily intended for the calibration of continuous tritium-in-air detectors for tritium in the form of water vapor is presented. It can also be used to study the effects of a change in the environmental conditions on the performances of a detector. The parameters that can be controlled are the tritium concentration, the absolute water content of the air, the flow rate of the sampled air and to a limited extent the atmospheric pressure. The system used consists essentially of a source of dry air which is bubbled into tritiated water under controlled conditions before being passed through the detector under test. The air is then flowed through a high efficiency tritium water vapour collector. The volume of air sampled and the concentration of the tritium in the tritium collector give the actual activity of the air sampled in the detector under test. This method is capable of yielding a maximum precision of 3 to 4% in the measurement of tritium concentrations in the air produced. (auth)

36801 (AEET/NP/12) CONTROL CIRCUITS FOR AUTOMATIC OPERATION OF NEUTRON SPECTROMETERS. Iyengar, P. K.; Vijayaraghavan, P. R. (Atomic Energy Establishment, Trombay (India). Nuclear Physics Div.). 1964. 35p. Dep. mn.

Some of the circuits developed for automatic operation of crystal spectrometers are described. (M.O.W.)

36802 (BNL-923) THE BROOKHAVEN ^{60}Co SOURCE ASSAY UNIT—AN INSTRUMENT FOR MEASURING AND RECORDING THE ACTIVITY OF ^{60}Co SOURCE ELEMENTS. Muller, A. C.; Silverman, S.; Kuhl, O. A.; Davis, C. R.; Rizzo, F. X.; Galanter, L. (Brookhaven National Lab., Upton, N. Y.). Apr. 1965. Contract AT(30-2)-Gen-16. 9p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

An instrument suitable for efficient analysis of the activity distribution and total activity of ^{60}Co strip sources was designed and constructed. The electrical signal derived from a point-by-point assay of a source is amplified and applied to a strip chart recorder to produce a permanent record of the activity distribution and total activity of each source. By using the records of ^{60}Co sources categorized in this manner it is now possible to construct source plaques designed to utilize an array of specially selected source strips. (auth)

36803 (BNL-9146) LARGE HYDROGEN BUBBLE CHAMBER DESIGN. Palmer, R. B. (Brookhaven National Lab., Upton, N. Y.). Mar. 31, 1965. Contract AT(30-2)-Gen-16. 15p. (CONF-650111-5) Dep.(mn); $1.00(cy), 1(mn) CFSTI

From CERN Informal Neutrino Conference, Geneva.

A description is given of a proposed 14-ft-dia nearly spherical hydrogen bubble chamber. The problems involved in illumination, photography, beam physics, magnetic-field production, and production of multiple expansions of the chamber during one beam pulse (from the Brookhaven AGS) are reviewed. The characteristics of Ne and propane as working gases for the chamber are discussed. The concept of using Ne as the filler gas, with a bag full of H_2 in the center of the chamber, is analyzed. (T.F.H.)

36804 (BNL-9218) RECENT DEVELOPMENTS IN HIGH-ENERGY COUNTERS. Yuan, Luke C. L. (Brookhaven National Lab., Upton, N. Y.). [May 12, 1965]. Contract AT(30-2)-Gen-16. 18p. (CONF-650510-4). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Purdue Conference on Instrumentation for High Energy Physics, Lafayette, Ind.

Improvements and modifications in high-energy particle detectors are summarized, with particular attention to Cherenkov counters, time-of-flight methods, scintillation hodoscopes with on-line computers, detectors using the relativistic rise in ionization, transition radiation detectors, and solid state detectors with internal pulse amplification. (T.F.H.)

36805 (BNWL-SA-121) AN INCREMENTAL DATA RECORDING SYSTEM FOR LOW LEVEL SPECTROMETRY. Brauer, F. P.; Connally, R. E.; Kaye, J. H.; Schlosser, J. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1, 1965. Contract AT(45-1)-1830. 22p. (CONF-650401-6). Dep.(mn), $1.00(cy), 1(mn) CFSTI.

From American Chemical Society, Detroit.

An incremental data recording system was applied to low-level single and multiparameter gamma and x-ray spectrometry. The system hardware includes three ADC's (analog to digital converters) with coincidence logic circuits. The digitized pulse height of an accepted event from each ADC is punched on paper tape. Time and identification information are automatically punched on paper tape at the beginning of each pre-set live time period. The punched paper tape is converted to computer-compatible magnetic tape. Various detector assemblies can be used with the converters and recording system. The system software includes a paper tape to magnetic tape conversion routine, an analysis and file maintenance program, a printed display program, a channel summing program, and

a weighted least-squares routine used for quantitative analysis of the spectra. All programs are written for use with an IBM-7090 computer. The system was used for various low-level radiochemical analyses involving x-ray-gamma, gamma-gamma, and beta-gamma coincidence techniques. (auth)

36806 (BNWL-SA-163) NEUTRON FLUX SENSOR DEVELOPMENTS. Worlton, D. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 15, 1965. Contract AT(45-1)-1830. 29p. (CONF-650526-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From 7th Tripartite Instrumentation Conference, London.

Encouraging results were obtained in both the regenerating and microwave methods of obtaining improved reactor in-core neutron flux measurements. In the former case, the concept was established on firm technical footing and experimental demonstration was achieved. Although operational difficulties were encountered with the first experimental units, these are thought to be a result of fabrication difficulties which will be corrected with subsequent models, presently being designed. Plans are to further demonstrate this method with fabrication and irradiation of several more chambers this coming year. The microwave results are particularly encouraging in view of obvious correlation between measured data and known (approximately) flux densities. Work remains to be done, however, to explain certain discrepancies between measured and theoretically predicted results. Hopefully, these will be resolved during the coming year. It is further hoped that it will be possible to demonstrate the high temperature potential of the microwave technique by application in high temperature environments clearly beyond the capabilities of other methods. (auth)

36807 (CEA-R-2722) ETUDE DES DETECTEURS EPAIS AU SILICIUM COMPENSE NUCLEAIREMENT. (Study of Thick Nuclear-Compensated Silicon Detectors). Yves Le Coroller (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Feb. 1965. 120p. Dep.(mn).

Thesis submitted to Universite, Paris.

The controlled realization of thick detectors by nuclear compensation from the theoretical and experimental points is described in detail. The performances of the detectors obtained are studied (electrical characteristics and detection and spectrometry of penetrating radiations). The results show that the compensated diodes having an effective thickness of two millimeters operate satisfactorily as detectors for applied voltages of about 500 volts. The resolutions observed are then about 2% for mono-energetic electrons. (M.O.W.)

36808 (CERN-65-19) A SYSTEM TO DETECT SEVERAL SPARKS IN A SONIC SPARK CHAMBER. Freytag, D.; Smith, A. J.; Laverriere, G. (European Organization for Nuclear Research, Geneva (Switzerland)). May 24, 1965. 24p.

A sonic detection system for the reconstruction of several sparks occurring simultaneously in a spark chamber was developed and tested. Up to four sparks could be resolved in a single gap, using four microphones and detecting in each microphone the successive signals from the different sparks. The resolving power for double sparks was 25 mm, the accuracy of reconstruction about 1 mm for an active area of the spark chamber of 1.30×0.80 m^2. The efficiency of reconstruction for double spark events was 80% unambiguous reconstruction in a single gap using four microphones. Including events showing added ambiguous spark locations the efficiency for double spark events was (94 ± 4)%. For three spark events only 20% of all events could be resolved unambiguously while a further 35% showed added ambiguous spark locations. In the remaining events one or more spark locations were lost (6% for two-spark events, 45% for three-spark events). The appearance of ambiguous spark locations and the loss of genuine spark locations can be approximately calculated. From these estimates and the analysis of the experimental data one concludes that it should be possible to improve on the detection efficiency for three-sparks using four microphones per gap, and further that with five or six microphones per gap a spark multiplicity of five should be handled with reasonable efficiency. A Fortran computer program which takes the numbers recorded in the sonic system scalers and computes the positions of the sparks was written. (auth)

36809 (CERN-65-25) EXTRAPOLATION CHAMBER FOR SURFACE DOSE MEASUREMENTS. Charalambus, S.; Baarli, J. (European Organization for Nuclear Research, Geneva (Switzerland)). June 28, 1965. 20p. Dep.(mn)

A portable extrapolation chamber to measure the dose rate at the surface of pieces of radioactive materials is described. The problems connected with the computation of dose rate from the cavity ionization, the operation and some characteristics of the chamber are also discussed. Experimental results from measurements of surface dose rates of materials exposed to the high-energy radiation of CERN accelerators are presented. (auth)

36810 (IA-1003) CALCULATION OF GAMMA RAY ENERGY RESPONSE FOR A FLAT SILVER METAPHOSPHATE GLASS DOSIMETER. Feige, Y.; Sever (Strop), J.; Alterovitz, S. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Jan. 1965. 16p. Dep. mn.

The energy response of a flat silver metaphosphate glass dosimeter was calculated for exposure to gamma rays in the energy range of 10 kev–1 Mev. The processes considered were: a) photoelectric absorption, b) fluorescence escape, c) Auger electron emission, d) Compton absorption, and e) escape of secondary electrons from the glass. The energy response was found to be flat above 500 kev, with a peak at about 50 kev due to the high absorption coefficients of silver and barium at low energies. The correction for fluorescent escape which results in a reduction of about 10% in the relative height of the peak may partly explain the discrepancy between the calculated and experimental results reported by Thornton and Auxier for cylindrical glass rods of identical composition. (auth)

36811 (IS-1072) I. S. U. GUTS SYSTEM FOR KINEMATICAL ANALYSIS OF BUBBLE CHAMBER DATA. Kernan, William J.; Higby, William J.; Boessenroth, Iva H. (Ames Lab., Iowa State Univ. of Science and Tech.). Nov. 1964. Contract W-7405-eng-82. 81p. Dep(mn); $3.00 (cy), 2(mn) CFSTI.

A description is presented of the I. S. U. GUTS system for the kinematical analysis of bubble chamber data. As better methods of treating certain aspects of this problem are developed, this system is updated. The version of GUTS discussed is Version III. (auth)

36812 (MIT-2098-155) GUIDED FLYING SPOT SYSTEMS FOR SPARK CHAMBERS. Deutsch, Martin (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). [June 20, 1965]. Contract AT(30-1)-2098, 6p. (CONF-650510-6) Dep.(mn); $1.00(cy), 1(mn) CFSTI

From Purdue Conference on Instrumentation for High Energy Physics, Lafayette, Ind.

The efficiency and operation of raster-scan and programmed-scan flying-spot systems for spark-chamber track analysis are compared and evaluated. (T.F.H.)

36813 (ORNL-3778(p.19-21)) IMAGE FORMATION IN A HIGH-RESOLUTION ELECTRON MICROSCOPE. Welton, T. A. (Oak Ridge National Lab., Tenn.).

A detailed numerical study of the image plane intensity distribution in an electron microscope has been performed for various configurations of atoms in the object plane, for a variety of beam energies, for different defocus distances, and for primary and secondary spherical aberrations. An apparently feasible high-resolution instrument will reliably image medium and heavy atoms. (auth)

36814 (ORNL-3778(p.125-7)) RESPONSE OF GERMANIUM AND SILICON DETECTORS TO ENERGETIC BRO-

MINE AND IODINE IONS. Walker, W. W.; Moak, C. D.; Dabbs, J. W. T. (Oak Ridge National Lab., Tenn.).

Pulse-height response of germanium and silicon surface barrier detectors to ^{79}Br and ^{127}I ions has been determined; detector resolutions and pulse-height defects have been shown to be similar for the two types of detector, and it has been shown that resolution and pulse-height defect are only partially related, if at all. (auth)

36815 (ORNL-P-1383) COMPARISON OF VARIOUS METHODS OF RATE RECORDING. Harris, C. Craig; Satterfield, M. M.; Bell, P. R.; Ross, D. A. (Oak Ridge National Lab., Tenn.). [n.d.]. Contract W-7405-eng-26. 18p. (CONF-650313-2) Dep.(mn); $1.00(cy), 1(mn) CFSTI

From Symposium on Nuclear Medicine, Philadelphia.

To investigate the relative merits of the various devices, a device is constructed that exposes predetermined amounts of a source to a counter and is therefore a count rate function generator. Using this device, comparisons were made for a conventional count-rate-meter, the true-average rate-meter, and a multi-channel scaler (which operates exactly as a digital-rate-meter but with point readout). Conclusions based upon these comparisons are presented. (M.O.W.)

36816 (PPAD-2137-549) BUBBLE CHAMBER MEASUREMENTS ON-LINE TO A PDP-5 PDP-1 SYSTEM. Bazin, M.; Benoit, J.; Blumenfeld, H.; Nauenberg, U.; Zacher, R. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). May 19, 1965. Contract AT(30-1)-2137. 8p. (CONF-650510-5). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Purdue Conference on Instrumentation for High Energy Physics, Lafayette, Ind.

An on-line measuring system was designed for 10 measuring machines. A 12K 12-bit word PDP-5 computer is the central unit of the system. It performs all logical checks permitted on the data from the given parameters and labels for each event. A fast data link between the PDP-5 and a PDP-1 computer gives the possibility of on-line geometrical reconstruction in the PDP-1. A measuring station can give 10 commands to the computer besides sending data, and the computer can give 14 replies in the form of error lights. The data is formated for THRESH input by the PDP-5 and put on an incremental tape recorder in a form directly readable by a 7094 computer. (auth)

36817 (RT/FI(64)-20) REVIEW OF NEUTRON SPECTROMETRY WORK AT THE C.N.E.N. LABORATORIES OF ISPRA. Caglioti, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Nov. 1964. 9p. Dep.(mn).

The research program of slow neutron spectrometry, carried out by several people during the last four years at a beam hole of the Ispra-1 reactor equipped with a crystal spectrometer, is presented and briefly discussed. The work consists of a systematic analysis of the experimental methods and techniques of conventional and elastic neutron diffraction including, in particular, a number of studies for optimizing resolution and luminosity of two-axis and, in some cases, three-axis neutron crystal spectrometers and physics experiments on the structure and dynamical behavior of solids and liquids. A comprehensive bibliography is included. (auth)

36818 (TID-20736) AN ANALYTICAL TREATMENT OF A CIRCUIT FOR RATIO AND DIFFERENCE OF CHARGES. Shonka, Francis R. (Saint Procopius Coll., Lisle, Ill. Physical Sciences Lab.). [n d.]. Contract AT(11-1)-323. 14p Dep.(mn); $1.00(cy), 1(mn) CFSTI

A circuit for measuring both the ratio and the difference of the outputs of two ionization chambers is described. The same charges used in the ratio measurement are subsequently used for measuring their difference. A complete analysis of the circuit, including formulae for sensitivities, calibrations, and errors serves to demonstrate a method of analyzing ionization chamber circuits. The general equation and a ratio formula for the Kemp comparator are derived. (auth)

36819 (TID-21901) APPLICATION OF FIELD-EFFECT TRANSISTORS IN LOW-NOISE WIDEBAND VOLTAGE AND CHARGE-SENSITIVE PREAMPLIFIERS. Scientific Report No. 5. Blalock, T. V.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Mar. 15, 1963. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 38p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Low noise wideband voltage and charge sensitive preamplifiers using field-effect transistors in the input stages were designed, constructed and tested. The basic amplifier section is a field-effect transistor driving a bipolar transistor cascade. Experimental data are included to indicate the performance characteristics of these amplifiers. One of the voltage sensitive amplifiers described has an input resistance greater than 10 megohms, input capacity less than three picofarads, a 10-90% risetime of 300 nanoseconds, a gain of 950, and an equivalent noise voltage at the input of 5.6 microvolts rms. The noise resolution of the charge sensitive preamplifiers discussed is about 12 kev fwhm for a detector capacity of 25 picofarads. A qualitative discussion of pertinent field-effect transistor theory is given. The necessary amplifier noise terminology for interpretation of the performance of these preamplifiers is presented. (auth)

36820 (TID-21926) STABILIZED LOW-POWER OPERATION OF THE PERSONNEL RADIATION MONITOR. Scientific Report No. 7. Kennedy, E. J.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Mar. 22, 1963. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 36p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Four stabilized low-power circuits were developed for a personnel radiation monitor. These circuits are shown. All circuits are operable within the temperature range of 0 to 120°F. The minimum theoretical battery life at room temperature (75°F) for all circuits is, in the absence of radiation exposure, greater than one year. The performance data for these four circuits are shown. A prototype model of the best circuit, requiring four silicon and two germanium transistors, was constructed for actual battery lifetime evaluation. This circuit has been operating satisfactorily for 4½ months. (auth)

36821 (UCRL-11995) ORTHOGONAL DISPERSION SPECTROMETER FOR MISSING MASS SPECTRA. Ankenbrandt, C. M.; Clark, A. R.; Cork, Bruce; Elioff, T.; Kerth, L. T.; Wenzel, W. A. (Lawrence Radiation Lab., Univ. of California, Berkeley). May 6, 1965. Contract W-7405-eng-48. 19p. (CONF-650510-7). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

For interactions of the type $M_1 + M_2 \rightarrow M_3 + M_4$ the kinematics of both initial particles and one secondary particle determine the reaction completely. Given a fixed initial state and any missing mass M_4, the momentum-angle correlation for particle M_3 is determined uniquely. In the spectrometer described, this correlation is preserved as a line image in the focal plane of a double focusing magnetic lens. Dispersions both in the plane of production and at right angles to it separate the images corresponding to different values of M_4, for which the spectrum is obtained directly by means of a 28-counter hodoscope in the focal plane. Each hodoscope counter is gated with a scintillation and Cherenkov counter telescope to identify particle M_3. During each beam pulse the outputs from the hodoscope counters are recorded on 10 Mc scalers. Between accelerator pulses the contents of these scalers are read onto magnetic tape and into a PDP-5 computer, which accumulates, corrects, and displays the data continuously to provide an on-line monitor. (auth)

36822 (USNRDL-TR-832) COMPUTER CORRECTION FOR SHIFTS IN GAIN AND BASELINE IN GAMMA-RAY SCINTILLATION PULSE-HEIGHT SPECTRA. Covell, D. F. (Naval Radiological Defense Lab., San Francisco, Calif.). Feb. 2, 1965. 25p.

In the quantitative analysis of multicomponent pulse height spectral data, precision depends upon (1) the

statistical variation inherent in the radioactive decay process, (2) statistical variations in the detection process, and (3) instrumental variations. The nature of the statistical variations in categories 1 and 2 are well understood and easily considered in the estimation problem. Category 3 variations are more difficult to evaluate and correct. The main variations observed in this category are of gain and baseline. In order to determine the instrumental conditions that prevail at the time of measurement, and spectrum of a standard (^{44}Ti) was obtained immediately before experimental spectra were obtained. This standard spectrum was then compared to a reference standard spectrum to obtain estimates of gain and baseline status, and appropriate corrections were applied to the experimental data. This technique, which can correct for shifts in both baseline and gain in excess of one channel (with respect to channel 256 of a 256-channel system), is capable of making corrections of as little as $\frac{1}{20}$ of a channel. Improvement in the resultant quantitative estimation of the constituents of multicomponent pulse height spectra is demonstrated. The method should provide the basis of a good quality control procedure for the scintillation gamma spectrometer, provided the spectrometer data can be conveniently entered into a computer. (auth)

36823 (USNRDL-TR-842) DOSIMETRY FOR LARGE ANIMAL EXPERIMENTS USING MULTIPLE Co^{60} SOURCES AND 1-MVP X RAYS. Menkes, C. K. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 21, 1965. 26p.

A quadrilateral configuration of four movable uncollimated ^{60}Co sources with a total activity of 9000 curies was used to obtain exposure measurements in air and depth doses in a masonite phantom for radiation experiments involving sheep. The depth dose distribution in the phantom in the four source exposures is compared to distributions obtained using a single collimated ^{60}Co source four times in succession to simulate the four source array and exposure geometry, and to 1 Mvp x rays in a bilateral exposure. Distributions of the quadrilateral gamma and x ray exposures differed quantitatively by no more than 5% throughout the phantom thickness. Ionization measurements were made in outdoor pens built to house one hundred sheep individually during chronic low-level exposures ranging from 500 mR/hr to 4 R/hr. Exposure rates at the two rows of pens were varied by using several source arrangements. Bilateral depth dose distributions in a sheep phantom exposed in the pens showed that the radiation from the uncollimated sources at the distances of the pens was less penetrating than from a collimated ^{60}Co source at a closer distance (corrected for inverse square effect), and more penetrating than from 1 Mvp x rays except at the phantom surfaces. (auth)

36824 (WCAP-5482) SILICON CARBIDE HIGH TEMPERATURE NEUTRON DETECTORS FOR REACTOR INSTRUMENTATION. Ferber, R. R.; Hamilton, G. N. (Westinghouse Electric Corp., Pittsburgh, Pa.). [1964]. Contract AT(30-1)-2827. 5p. (CONF-650602-6). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

Miniature SiC neutron detectors were constructed by evaporation of a ^{235}U layer on to the sensitive surface of the diode to act as a neutron conversion coating. Diagrams show the response of a typical SiC diode at 100°C to californium-252 fission fragments and α particles. A diagram showing the potential of the SiC neutron detector as a flux mapping device in an operating reactor is included. (M.O.W.)

36825 (UCRL-Trans-1198(L)) ACTIVE ELECTRONIC SPECTRA IN IONIZATION CHAMBERS. Aglintsev, K. K.; Mitrofanov, V. V.; Smirnov, V. V. Translated by B. J. Hazzard (Univ. of California, Livermore), from At. Energ. (USSR), 2: 66-8(1950). 11p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI. $1.60(fs), $0.80(mf) JCL.

A study of electron spectra in ionization chambers and counter tubes was made, in order to obtain information for computing the efficiency of the counters. Electron spectra emitted by 100- to 2620-kev gamma rays from a plexiglass target similar to the wall of an ionization chamber were measured at angles of 0, 15, 30, 60, 90, and 180°, using ^{60}Co, ^{137}Cs, and RaTh gamma sources. The ionization effect of electrons ejected at the various angles is derived. (M.J.T.)

36826 CONTINUOUS OUTDOOR AIR SAMPLER. Mitchell, Kenneth K. (Union Carbide Corp., Paducah, Ky.). Am. Ind. Hyg. Assoc. J., 26: 285-8(May-June 1965).

A 115-volt electric-powered air sampler that continuously samples outdoor air with high efficiency for particulate gaseous contaminants was assembled and tested by field use. It operates with little attention for more than a week and was successfully tested in ambient temperatures ranging from –10 to 100°F. The sampler consists of a vacuum pump which pulls air first through a membrane filter for removing particulate materials and then through a liquid-filled scrubber for removing gaseous contaminants. The complete sampler, including the aluminum cabinets which house the sampling equipment, costs several hundred dollars. (auth)

36827 GERMANIUM n-i-p DETECTOR WITH HIGH RESOLVING POWER FOR SMALL- AND MEDIUM-ENERGY γ QUANTA. Maslova, L. V.; Matveev, O. A.; Ryvkin, S. M.; Sondaevskaya, I. A.; Strokan, N. B. At. Energ. (USSR), 18: 654-5(June 1965).

Descriptions are given of the technology, construction, and efficiency of germanium detectors using p-type germanium with specific resistance 3 to 10 ohm · cm. The detector is designed for measuring γ-quantum energies with amplitude resolving power 1.333 Mev. Diagrams are given of the design with the guard ring and connecting switch. The γ spectra of ^{60}Co and ^{181}Hf and ^{137}Cs preparations are included. (R.V.J.)

36828 NUCLEAR INSTRUMENTATION PROBLEMS OF AGRICULTURAL ISOTOPE LABORATORIES. Pethes, Gyoergy (National Atomic Energy Commission, Budapest). Atomtech. Tajekoztato, 8: 10-14(1965). (In Hungarian)

A committee was organized to provide assistance in the field of instrumentation to the more than 20 isotope research laboratories established under the auspices of the Agricultural Division of the Hungarian National Atomic Energy Commission. The instruments studied were used for experimentation in genetics, plant biology, plant protection, soil science, irrigation, forestry, animal husbandry, and veterinary medicine. High-energy β emitters, such as ^{32}P, are employed in plant biology; γ emitters and more recently soft β emitters are used in the field of animal pathology. Liquid scintillation counters were recommended for this type of measurement. Nitrogen-15-labeled compounds were identified by means of a mass spectrometer of Soviet manufacture. A simple, rugged and inexpensive soil-humidity meter based on a neutron scattering system was employed successfully in several of the cooperating institutes. Needs are identified as: a central film-dosimetry laboratory, a method for evaluating radiochromatographic data reliably; and a well-organized repair service for keeping the available instruments operational. (TCO)

36829 INSTRUMENTATION FOR RADIATION. Inoue, Kyojiro (Electrical Research Lab., Tokyo). Genshiryoku Kogyo, 11: No. 4, 45-50(Apr. 1965). (In Japanese)

The progress in instrumentation for radiation detection and production for the past ten years in Japan is reviewed. Continued improvements to ionization chambers, the standard dosimetry instruments, made them very versatile. Small survey meters were developed for less exacting use. Japan was previously dependent on foreign imports for neutron detection equipment, however, these instruments are now being manufactured domestically. Descriptions and operating characteristics of three neutron detector models are listed. Recent advances include incorporation of semiconductor units for radiation detection. The G-M tube is being replaced by scintillators coupled with photomultipliers. Improved electrometers

were prepared. High-speed scalers facilitated counting. Pulse-height analyzers made the transition from single channels to multi-channel arrangements. Instrumentation was also improved for producing radiation. These include particle generators (Van de Graaff, betatron) and linear accelerators. The discussion of these instruments centers mainly around equipment presently in use in the United States. (TTT)

36830 TWO-PARAMETRIC RADIOACTIVE GAMMA-SOUNDING EQUIPMENT FOR HIGH TEMPERATURE. Liszt, Ferenc. Geofiz. Kozlemen., 13: 439-62(1964). (In Hungarian)

The design and operation of transistorized electronic circuits for gamma-sound equipment are discussed. A detailed study of impulse-gain and generation of high-voltage is described, including theoretical calculations and diagrams of actual measurements. Special attention was paid to the applicability of silicon transistors at 120° C. (auth)

36831 AN EXPERIMENTAL CALIBRATION OF FISSION FOIL THRESHOLD DETECTORS. Johnson, D. R.; Thorngate, J. H.; Reinhardt, P. W.; Davis, F. J. (Oak Ridge National Lab., Tenn.). Health Phys., 11: 759-62 (Aug. 1965). (ORNL-P-574)

A surface-barrier detector was mounted in a Cd cup and a ^{10}B shield and used with thin fissile targets to calibrate the fission foils used in the Hurst threshold detector system. The efficiency of the detector was found to be 0.81 counts per fission by irradiating it with known fluences of 14.8 Mev neutrons from a Cockroft-Walton generator. Then, the detector and the various fissile targets were exposed to neutrons from the HPRR. Several Hurst threshold detector systems were irradiated simultaneously in the same geometry. Fission product decay curves were calculated for ^{239}Pu, ^{238}U, and ^{237}Np using the fast neutron fluences as measured with the diode detector and the weights and gamma count rates of the standard fission foils. The decay curves describe as a function of time the gamma activities of the foils per g per 10^{10} n/cm^2 above their threshold energies. A method is given whereby nearly any scintillation counting system can be calibrated so that the decay curves may be used directly. First collision tissue dose measurements at the HPRR using the threshold detector method and the Hurst proportional counter (Radsan) have shown agreement within 10%. (auth)

36832 GAS PROPORTIONAL, ALPHA, BETA-GAMMA CONTINUOUS AIR MONITOR. Ello, J. G.; Smith, W. H.; Pingel, J. H. (Argonne National Lab., Ill.). Health Phys., 11: 773-78(Aug. 1965).

The Gas Proportional, Alpha, Beta-gamma Continuous Air Monitor was developed for immediate and simultaneous detection of long half-life radioactive airborne particulate collected on a large fixed filter media. The alpha and beta-gamma counting rates and the nullification or differentiation of these counting rates are indicated separately on linear count rate meters and strip chart recorders. Efficiency of the alpha section was found to be 35% and the beta section to be 20% of total disintegration from a flat plate standard. Sensitivity of the monitor at a flow rate of 35 cubic meters per hour is such that a level of less than 1 MPL may be detected within an hour under average operating conditions. (auth)

36833 THE EFFECTS OF CADMIUM RATIO ON FILM BADGE NEUTRON DOSIMETRY BY CAPTURE GAMMAS. Block, S. (Univ. of California, Livermore). Health Phys., 11: 785-6(Aug. 1965). (UCRL-12096)

That the darkening produced by capture gamma rays from the Cd filter of a film badge is a constant per unit thermal neutron dose when interpreted in R was shown experimentally and theoretically by Caruthers and Story. However, it is pointed out that for any given flux of thermal neutrons, there is a marked difference in the blackening of the film behind the Cd, depending on the Cd ratio of the neutron beam. Therefore it is suggested that the Cd ratio of the flux should be known when using this method of neutron dosimetry. (H.G.D.)

36834 OPTIMUM WINDOW SETTING IN A SPECTROMETER FOR LOW-LEVEL ACTIVITY COUNTING. Tanaka, E. (National Inst. of Radiological Sciences, Chibashi, Japan). Intern. J. Appl. Radiation Isotopes, 16: 405-12 (July 1965).

In low-level activity counting with a scintillation spectrometer, a differential discriminator was frequently employed when the sample nuclide is known. A simple graphical method of determining the optimum window of the differential discriminator, which gives the least statistical error in the results in a given measuring time, is described. The method is applicable when background and sample spectra are known, the latter spectrum being determined with an intense source of the sample nuclide. The method was also applied to the case where two nuclides were contained in one sample, the activity of each of them being determined by the use of two differential discriminators. (auth)

36835 CALCULATION OF CERTAIN CHARACTERISTICS OF COUNTER TELESCOPES. Kavlakov, S. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk, 13: 163-73(1965). (In Bulgarian)

Methods of calculating the angle distribution and the intensity of counter telescopes are systematized. Some new methods of determining the angle distributions for counter telescopes and tables of the boundary angles for the integration are given. Azimuthal angle distributions are introduced. Formulas are derived for the calculation of zenithal and azimuthal angle distributions in different sections of telescopes of all types. The integrals are calculated for determining the intensity of a telescope for certain values of γ in the law for the angular distribution of cosmic radiation. (auth)

36836 THE RESPONSE OF HIGH ALTITUDE IONIZATION CHAMBERS DURING THE 1954-1965 SOLAR CYCLE. Callender, R. H.; Manzano, J. R.; Winckler, J. R. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 70: 3189-3201(July 1, 1965).

The response of an integrating ionization chamber at 10 g/cm^2 depth in the atmosphere to particles of various rigidities is evaluated by using the change of ionization with latitude. This procedure yields the differential response curves at solar minimum and solar maximum and also the mean rigidity of response at any given latitude. For high latitude and Minneapolis, the mean responses are 2.5 bv and 3.2 bv, respectively, at solar minimum and 3.6 and 3.8 at solar maximum. The solar cycle effect at 10 g/cm^2 is evaluated using 250 balloon flights at Minneapolis and at high latitude. Total ionization minimum lags about 18 months behind sunspot maximum. The high-altitude ionization when compared with neutron monitors forms a single correlation curve over the solar cycle with significant deviations occurring only for a few months in 1957. It is concluded that the relative rigidity effects between 3.6 and 15 bv are very similar during the decreasing and increasing phases of the solar cycle. Comparison of data from ionization chambers of Pioneer 5 and Mariner 2 with data from detectors on earth shows no definite gradient effects. The larger intensity changes show a correlation between earth and deep space, but real fluctuations of smaller amplitude are frequently not correlated. (auth)

36837 DESIGN AND PROPERTIES OF THE WHOLE BODY SCANNER AT DUKE. Pircher, F. J. (Duke Univ., Durham, N. C.); Horn, E. G.; Reeves, R. J.; Buffalo, T. J. Nucl. Med., 6: 389-403(June 1965).

The whole body scanner described measures retention and distribution of radioisotopes in vivo. The values derived by computer analysis are expressed in fractions of the administered dose. A visual presentation of distribution is provided by the computer in the form of a radioactivity contour map that permits the detection and localization of concentrations of radioactive material. The instrument is capable of making measurements of radioisotopes at tracer and therapeutic dose levels. It is helpful in clinical investigations and it may enable us to improve the dosimetry of internal radiation. (auth)

36838 INFORMATION CAPACITY OF SCINTISCANS. Gregg, Earle C. (Western Reserve Univ., Cleveland, Ohio). J. Nucl. Med., 6: 441-58(June 1965).

All styles of collimators are characterized by having an optimum bore size—above which and particularly below which the information capacity diminishes. The straight bore collimator is slightly superior to the focussing collimator when viewing distributions in depth; the focusing collimator is superior when viewing reasonably well located planar distributions. Honeycomb and pinhole collimators have a much greater information capacity than mechanically scanned collimators simply because there are more detectors and each detector is recording during the total scan time. The visual presentation method is most important and cruder methods, such as dot-on-paper, reduce the available capacity simply due to the characteristics of the eye. The presentation system must be carefully designed to achieve the calculated maximum capacities. Information capacity calculations do not weight any particular size of signal areas. The information capacity of a given scintiscanning system changes roughly as the logarithm of the product of the specific activity and the time of scan. (auth)

36839 A DIAGNOSTIC-LEVEL WHOLE-BODY COUNTER. Morris, A. C. Jr. (Oak Ridge Inst. of Nuclear Studies, Oak Ridge, Tenn.). J. Nucl. Med., 6: 481-8 (July 1965).

A system of three whole-body counters was developed to bridge the sensitivity gap between the lower range of high-level counters and the upper limit of the low-level installations. Activities used at ORINS hospital range from the 150 mC therapeutic doses of ^{131}I or ^{198}Au to the mC region for medium-energy gamma emitters. Calibration and operation of the instrument system are also dismissed. (H.G.D.)

36840 THE DETERMINATION OF RADIATION CHARACTERISTICS BY TWO SIMULTANEOUSLY MEASURED VALUES. Krongauz, A. N.; Lyapidevskii, V. K.; Titov, A. A. Med. Radiol., 10: No. 6, 79-82(June 1965). (In Russian)

Methods for determining radiation characteristics with the aid of two detectors having different spectral specifications and means of simultaneously measuring two values at the outlet of a proportional detector are discussed. (auth)

36841 AN ELECTROMETRIC DEVICE FOR MEASURING THE INTEGRAL ABSORBED ENERGY OF ROENTGEN AND GAMMA-RADIATION. Yuschenko, N. G. Med. Radiol., 10: No. 6, 83-5(June 1965). (In Russian)

A device was developed which automatically measures the radiation energy absorbed in the body during x or gamma irradiation, according to the difference of energies measured at the entrance of the beam into the body and at its exit. The device consists of three plane ionization chambers and an electrometric system which computes the difference of the ionization currents in the chambers; the ionization chambers measure incident beam energy, energy backscattered from the subject, and energy transmitted through the subject. A simplified diagram of the device is shown, and the principle of its operation is described. (M.J.T.)

36842 LOW-NOISE PREAMPLIFIERS FOR NUCLEAR DETECTORS. Radeka, Veljko (Institute Ruder Boskovic, Zagreb). Nucleonics, 23: No. 7, 52-5(July 1965).

Noise relations for charge-sensitive preamplifiers are noted. The most common circuit configuration is described, and a comparison is made of recent results. Future developments are also discussed. It is found that present preamplifiers are adequate in detecting charged particles with energies above 10 Mev. (J.F.P.)

36843 NUCLEAR PULSE AMPLIFIERS. FUNDAMENTALS AND DESIGN PRACTICE. Fairstein, E. (Tennelec Instrument Co., Inc., Oak Ridge, Tenn.); Hahn, J. Nucleonics, 23: No. 7, 56-61(July 1965).

The sources of distortion within the amplifier are examined. The effects these sources produce are also explained, and designs to overcome these effects are discussed. Detector characteristics are also discussed. (J.F.P.)

36844 COINCIDENCE CIRCUITS AND TIMESORTERS. Gatti, E.; Svelto, V. (CISE, Milan). Nucleonics, 23: No. 7, 62-9(July 1965).

The design, performance, and characteristics of coincidence circuits and time sorters are given including medium-speed and fast-speed coincidence circuits. Circuit diagrams and graphs of functions involved are included. (J.F.P.)

36845 GEOMETRICAL CORRECTIONS FOR ANGULAR CORRELATION MEASUREMENTS WITH A LARGE SOURCE AND SMALL DETECTORS. Verheul, H.; Blok, J.; Boddendijk, H. G.; Vonck. B. G. (Vrije Universiteit, Amsterdam). Physica, 31: 565-72(Apr. 1965).

The results are given of calculations on the influence on the experimentally found angular correlation functions if a large rectangular or circular source and circular detectors are used. These corrections are especially important when solid-state detectors are used, because their linear dimensions are in general of the same order of magnitude as those of the source. (auth)

36846 ABOUT A NEW ADDITIONAL INTEGRATING DEVICE WITH DIGITAL MEASURING INDICATION FOR BOMKE DOSE-RATE-METER. Klose, E. (Radiologische Klinik und Poliklinik der Medizinschen Akademie, Erfurt, Ger. and Technische Hochschule, Ilmenau, Ger.). Radiobiol. Radiotherap., 6: 377-80(1965). (In German)

Starting from a known dose-rate-meter, a device is described that measures and records the dose digitally. (auth)

36847 EXPERIENCES IN ASSAYING THE EVALUATING DEVICE FOR LUMIMETER II THERMOLUMINESCENCE DOSIMETER. Herforth, L.; Frank, M.; Werner, K.; Lingertat, H. (Technische Universitaet, Dresden). Radiobiol. Radiotherap., 6: 381-5(1965). (In German)

Calibration of the Lumimeter II device is summarized, and the use of LiF dosimeters in hospitals is discussed. (auth)

36848 CONTRIBUTION TO THE MEASURING METHOD WITH A SCINTILLATION COUNTER. Potschwadek, B. (Universitaet, Rostock, Ger.). Radiobiol. Radiotherap., 6: 387-92(1965). (In German)

Measurement techniques used in uptake experiments are evaluated. (H.G.D.)

36849 ON THE RESOLVING POWER OF A NaI(Tl) SCINTILLATOR IN THE REGION OF SOFT X AND GAMMA RADIATION. Zakharko, Ya. M.; Chepelev, V. V. (L'vov State Univ., USSR). Ukr. Fiz. Zh., 10: 653-6 (June 1965). (In Ukrainian)

An analysis is given of the contribution of the NaI(Tl) crystal to the total resolution of scintillation detectors of x and gamma radiation of very low energies. It was found that the inherent resolution of the scintillator in the region of 5 to 2 kev energies is equal to zero and physical explanations of this phenomenon are presented. Some possibilities are discussed of improving the resolving power of detectors by using crystals with an elevated content of activating impurities and effective reflectors of scintillation light. (auth)

36850 MEASUREMENTS WITH A LIGHT-INTENSIFYING GAMMA SPECTROMETER WITH PLASTICALLY DEFORMED LiF CRYSTAL. Moll, Walter (Technische Hochschule, Munich). Z. Naturforsch., 20a: 730-6(May 1965). (In German)

A gamma spectrometer of the DuMond-type for the low-energy region, with a focal length of 50 cm and a solid angle of 4×10^{-3} sr was provided with a plastically deformed LiF monochromator. A light intensity of 3×10^{-6} at 20 kev and 0.8×10^{-6} at 100 kev was obtained with a resolution capability of 1% and 5%, respectively. The energy and intensity of a line at 31.75 kev was measured

along with known lines in the γ-spectrum of ^{183}Ta. (tr-auth)

36851 ON THE OPERATION OF DIAMOND COUNTERS OF NUCLEAR PARTICLES IN A STRONG ELECTRIC FIELD. Afanas'eva, E. A. Zh. Tekhn. Fiz., 35: 951-7 (May 1965). (In Russian)

In an effort to improve the time and energy resolution of diamond counters, their operation in the presence of an electric field of the order of 10^4 v/cm was investigated. Five diamond samples were investigated, the ultraviolet absorption edges of all of which were at wavelengths shorter than 300μ. The diamonds were cut in the form of approximately 1-mm-thick wafers, which were provided with sputtered gold electrodes. Plutonium alpha particles (approximately 5 Mev) traversed the crystal wafers parallel to the electric field from cathode toward anode. When the electric field was sufficiently strong, the pulse-height distribution showed a clear maximum which shifted toward smaller pulses when the alpha energy was reduced by means of an aluminum foil. The best energy resolution obtained was 15%. The energy required for the formation of an electron-hole pair was determined from the variation of the maximum pulse height with field strength; it is found to vary from 74 to 175 ev for the different samples. Depolarization effects were observed, and there was a field strength above which the dark current increased sharply and the electric properties of the counter altered. The results of this work differ considerably from some other observations; possible reasons for the discrepancy are discussed. (ATD)

36852 CALCULATIONS AND CERTAIN ION-OPTICAL CHARACTERISTICS OF ELECTROSTATIC FOCUSING SYSTEM. Dymovich, V. I.; Sysoev, A. A. p.15-26 of "Fizicheskaya Elektronika. Vypusk 2." Moscow, Atomizdat, 1965. (In Russian)

Dual and triple focusing has been used in making mass-spectrometric analyzers with high illuminating and resolving power. A multielectrode electrostatic focusing system (efs) was designed and constructed which changes continuously over a wide range of changes in the electrode potential. Cylindrical, spherical, and toroidal fields may be obtained, and the axially symmetrical fields formed eliminate the condenser. The equations for the work are developed mathematically, and a diagram of the equipment is presented. Experimental results are given, and a comparison of the experimental values with calculated values shows that the efs ion-optical characteristics are exceptional even with a relatively low degree of precision in the electrode manufacture. The system geometry is not critical, and the height and width of the field can be changed without changing the ion beam dimensions. (TTT)

36853 APPLICATION OF A SOURCE WITH QUADRUPOLE LENSES FOR INCREASING RESOLVING POWER OF A MASS SPECTROMETER. Dymovich, V. I.; Osipov, G. A. p.33-40 of "Fizicheskaya Elektronika. Vypusk 2." Moscow, Atomizdat, 1965. (In Russian)

Quadrupole lenses have been used as ion-optical systems in a mass spectrometer for the purpose of increasing the illuminating power and for monochromatization of the ion beam of a gaseous source. Such a lens system is four symmetrically placed cylindrical electrodes, the potentials of facing electrodes being equal. A source with a quadrupole lens system was designed and constructed, and used in a mass spectrometer. For recording the ^{40}K current, an amplifier with a resistance of 4.7×10^5 megohms was used, and for ^{39}K and ^{41}K, 4.7×10^4 megohms. The equipment was adjusted for maximum ^{41}K current by changing the potential of the lenses and by small displacement of the beam. The arrangement that gave the least spherical aberration, and the best ^{40}K separation, is shown. Since the properties depend on the ion energy, the source may be used both for quenching of ions formed in dissociation and for recording them. (TTT)

36854 SPHERICAL ABERRATION OF AXIAL-SYMMETRICALLY ENCLOSED SECTOR INSERTED ELECTRIC AND MAGNETIC SECTOR FIELDS. Dybov, P. T.; Dymovich, V. I. p.41-6 of "Fizicheskaya Elektronika. Vypusk 2." Moscow, Atomizdat, 1965. (In Russian)

Dual focusing of ion beams is of interest chiefly because the length of an ion-optical path in enclosed electric and magnetic fields is significantly less than that in focused systems with a sequential field arrangement. Calculations show that in enclosed fields, dispersion may be greater than in a homogeneous magnetic field, which is important in recording doublet masses. One of the disadvantages of enclosed systems is the necessity of increasing the magnet gap for placement of the electrodes that form the electric field, but the decrease in magnetic field strength may be compensated by the corresponding decrease in the beam ionization energy, which does not decrease the resolving power of the mass spectrometer. Results of calculations of the second-order spherical abberation in sector-crossed axially symmetrical electric and magnetic fields with rectilinear limits and normal beam entrance may be used for calculating the spherical aberration of paraxial beams in axially symmetric fields. A formula is derived which can be used for calculating the spherical aberration of paraxial beams in electric, magnetic, and enclosed electric and magnetic fields; and numerical values of parameters of several fields are tabulated. (TTT)

36855 A MAGNETIC TAPE RECORDING SYSTEM AND ITS USE IN SPARK CHAMBER WORK. Fulbright, H. W.; Bahnsen, A.; Hamann, A.; Gustinis, J. (Univ. of Rochester, N. Y.). pp 110-21 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A magnetic tape recording system has been set up based on a modified tape recorder from an IBM 650 computer. The system is suitable for application in connection with many types of nuclear experiments. It has been used chiefly in connection with several spark chambers for experiments in nuclear structure physics. These chambers make use of the sonic location principle. (auth)

36856 LOGICAL SURVEYOR FOR SEQUENTIAL OPERATIONS. Debaisieux, J.; Depiesse, G.; Bruylants, G. (Institut Interuniversitaire des Sciences Nucleaires, Brussels). pp 437-43 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The various sources of loss of time in bubble-chamber photo data handling are outlined. A summary is presented of various studies to improve the efficiency of the instrumentation and to avoid errors by surveying continuously the order of operation. The steps in the automation of the data handling include the automatic sequence indicator, logical surveyor, geometrical identifier and instrumentation logic. (L.B.S.)

36857 ADVANCES IN GAS-DISCHARGE CHAMBER TECHNOLOGY. Dolgoshein, B. A. pp 503-20 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

A review is presented covering the chamber with large interelectrode distances with crossed electric and magnetic fields; the projection camera in which, at incident angles above 40 to 45° to the electric field, the particle tracks consist of numerous small spark channels which develop along the field and project the path of the particle on the electrodes of the chamber; the streamer or spark chamber; the microwave chamber; and the light amplification chamber. Recommended for future study and development are chambers whose discharges do not proceed beyond the stage of electron avalanches; chambers with a rotating electric field (isotropic chambers); laser-illuminated chambers; and chambers whose avalanches are observed by resonant light scattering. (CFSTI)

36858 THE ACCURACY OF CHARGED PARTICLE MOMENTUM MEASUREMENTS IN TWO-ELECTRODE SPARK CHAMBERS WITH LARGE DISCHARGE GAPS. Asatiani, T. L. pp 521-42 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

Momentum measurements in large-gap spark chambers in the presence of magnetic fields gave new importance to the old question concerning the accuracy of curved track measurements. Distortions may be generated by multiple scattering of charged particles by the gas molecules, by the drift of electrons within crossed electric and magnetic fields during a simultaneous inhomogeneity of the electron field generated by the high-voltage pulse, and by systematic errors caused by distortions within the optical system. A review is presented covering errors in curvature determinations, distortions of the true track curvature, and experimental data concerning error determinations of momenta measured in spark chambers within magnetic fields. (CFSTI)

36859 CALCULATION OF EVENT REGISTRATION EFFICIENCY IN BUBBLE CHAMBERS USING MODELING. Shakhbazyan, B. A. pp 543-58 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian).

The essence of the method consists in taking into account all the available information about the dynamics of the process as well as about the conditions of the experiment (geometric limitations, registration probabilities, presence or absence of symmetries, etc.). Illustrative examples concerning the binary and single V^0 particle production and V^0 particle scattering on protons are worked out in details. Programs utilizing the complete information are already in use at the High Energy Laboratory of OIYal. (CFSTI)

36860 CORRECTION OF DISTORTIONS OF STEREOSCOPIC TRACK PHOTOGRAPHS. Livshits, E. M. pp 559-74 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

Distortions of oblique components of bubble chamber tracks on photographs affect adversely the geometric track model being recreated by the stereoscopic pair of frames. The geometry of the camera and errors introduced by the optical media of the bubble chamber are analyzed in detail with the aim of establishing ways for the removal of such distortions. Recommendations are incorporated into the procedures for the transformation of distorted pictures and the measurement of spatial coordinates. (CFSTI)

36861 IMPROVEMENTS IN OR RELATING TO RADIATION DETECTORS. Loveday, George Christopher (to E. K. Cole Ltd.). British Patent 989,115. Apr. 14, 1965. Filed Nov. 30, 1962.

A scintillation type radiation detector is patented in which the scintillator adapted to be bombarded by penetrative radiation such as gamma rays has a window with a number of photomultiplier tubes spaced from it and arranged to view overlapping areas of it. A pulse output is derived from the tubes whose amplitude is a function of the position of the projection of the scintillations on the window. Means are included that selectively use output pulses that lie between predetermined amplitude limits so as to obtain an indication of those scintillations only that are received within at least one predetermined area of the window. The area occupies only a part of the window. The pulse amplitude discriminating means is adjustable to determine the dimensions of the sub-area. By appropriate choice of the pulses from tubes lying on either side of predetermined coordinates on the scintillation window, a strip of the window or a second sub-area may be observed. (B.L.M.)

36862 THERMOLUMINESCENCE DOSIMETER FOR X AND GAMMA RADIATION. Schayes, Raymond Georges (to Manufacture Belge de Lampes, et de Materiel Electronique, S. A.). German Patent 1,192,330. May 6, 1965. Priority date Nov. 29, 1962, Belgium.

The dosimeter comprises a luminescent material mounted on the surface of a heated plate. The height of layer of the thermoluminescent material and the base plate is related so that all portions of the surface of the thermoluminescent layer simultaneously reach the same temperatures. This uniformity of heating is either achieved by increasing the height of layer of the thermoluminescent material from the rims to the center or by increasing the thickness of the base plate from the rims to the center. (Gmelin Inst.)

36863 STABILIZED SCINTILLATION DETECTOR SYSTEM WITH COMPARISON LIGHT PULSES OF CONSTANT AMPLITUDE TO CONTROL THE SENSITIVITY OF THE SYSTEM. Scherbatskoy, Serge A. U. S. Patent 3,179,801. Apr. 20, 1965. Filed Aug. 22, 1962.

A device is described that compensates for changes in the photomultiplier tube apparatus of a scintillation detector system and that provides an automatic controlling arrangement to ensure the stability of operation. A standard electric light source is provided in combination with means for feeding electrical energy to the source in current pulses of predetermined magnitude to produce light pulses from the light source of predetermined uniform intensity. The light source is positioned to cause the light pulses to impinge on the photoelectric device and produce current pulses. Means fed by these current pulses are operatively connected to controlling means for regulating the selectivity of the photoelectric system responsively to changes in the physical characteristics of the pulses. (B.L.M.)

36864 STABILIZED SCINTILLATION DETECTOR. Scherbatskoy, Serge A. U. S. Patent 3,184,597. May 18, 1965. Filed Aug. 23, 1962.

A means for stabilizing the overall sensitivity and calibration of a radiation detection system utilizing a phosphor and a photomultiplier tube is patented. A control arrangement is provided for automatically adjusting the voltage supply of the photomultiplier tube to compensate for any departure from normal operating conditions or change in photomultiplier characteristics. The arrangement includes a system for generating reference light flashes that are readily distinguishable from the flashes generated in the phosphor by radiation quanta. (A.G.W.)

Radiation Effects

36865 (FZK-224) SECOND TEST ON RADIATION EXPERIMENTATION FOR THE Q-FACTOR TECHNIQUE. Curtsinger, B. E.; Robinson, A. R. (General Dynamics/Fort Worth, Tex.). May 1965. Contract AF29(601)-6643. 50p. (AFWL-TR-65-18). CFSTI.

Irradiations of 180 transistors, four diodes, and two Si solar cells were carried out using the NARF GTR Irradiation Test System. The tests were performed in support of a project on development of the Q-factor technique, a method for describing bipolar transistor gain as a function of radiation exposure. The transistors were irradiated under closely controlled environmental conditions and bias levels. Data were taken before, during, and after the irradiation, and results will be analyzed subsequently. The test setup and techniques used are described, and the neutron dosimetry data are presented. (M.J.T.)

36866 (N65-20670) SATELLITES AND CHARGED CORPUSCULAR RADIATION. Downey, M. J. (Royal Aircraft Establishment, Farnborough (England)). [1963]. 30p. (RAE-TR-64009).

The data and facilities required to estimate the lifetime of a satellite in a given orbit, from the point of view of radiation damage to its components are discussed. A brief summary of measurements from chosen satellites is given, followed by considerations of radiation origins and the B, L coordinate system. The interaction of radiation with matter and the calculation of absorbed radiation doses are also described. The effects of radiation on various possible satellite components, such as semiconductors, and polymers, are outlined. (auth)

36867 (WL-TDR-64-62(Vol.II)) AUTOMATED DIGITAL COMPUTER PROGRAM FOR DETERMINING RESPONSES OF ELECTRONIC SYSTEMS TO TRANSIENT NUCLEAR RADIATION. VOLUME II. PREDICT CIRCUIT ANALYSIS PROGRAM. (International Business Machines

Corp., Oswego, N Y. Radiation Effects Dept.). Aug. 1964. Contract AF29(601)-5399. 193p. (AD-607408). CFSTI, $5.00 cy, $1 25 mf.

PREDICT is an IBM/7090/7094 program which automatically solves, from a description of the network topology, built-in differential and algebraic matrix equations which completely characterize the behavior of a complex network. The general approach in the PREDICT formulation does not limit it to radiation applications; the radiation problem is treated as a special case of the general circuit analysis problem. Information useful to circuit analysts and computer programmers for application of this program is included. A detailed description of PREDICT, a discussion of its use and operation, and example problems are included to demonstrate and verify its operation at other computing facilities. The last section contains information on machine requirements and off-line equipment necessary for the PREDICT system. (auth)

36868 (WL-TDR-64-62(Vol.III)) AUTOMATED DIGITAL COMPUTER PROGRAM FOR DETERMINING RESPONSES OF ELECTRONIC SYSTEMS TO TRANSIENT NUCLEAR RADIATION. VOLUME III. TREAT COMPONENT ANALYSIS PROGRAM. (International Business Machines Corp., Oswego, N. Y. Radiation Effects Dept.). Aug. 1964. Contract AF29(601)-5399. 302p. (AD-607409). CFSTI, $7.00 cy, $1.50 mf.

The TREAT (Transient Radiation Effect Automated Tabulation) system of six independent, but complementary, digital computer programs was developed to aid in the processing of data on transient and permanent effects of radiation on electronic components. Each program treats a particular aspect of the over-all processing task. Given raw laboratory data recorded before and after irradiation, the system provides calculated device parameters for each sample and the radiation induced change in these parameters. These data are combined with radiation environment information, also processed by the system, and applied to theoretical equations to predict the response or damage to device parameters during irradiation. Information on typical rather than specific devices and/or radiation environments is also available for typical response predictions. As many as 1000 samples each of transistors, diodes, and capacitors can be processed concurrently. A complete functional description of the system as well as all necessary operating instructions are included. (auth)

36869 BAND-FILLING CURRENT IN HEAVILY DOPED GaAs DIODES. Aukerman, L. W.; Millea, M. F. (Aerospace Corp., El Segundo, Calif.). J. Appl. Phys., 36: 2585-6(Aug. 1965).

The results of an investigation of the effect of radiation damage on the electroluminescence in heavily doped GaAs diodes at 77°K are presented. A band-filling model is proposed to account for the results. The model can account for the effect of radiation damage on the excess current in silicon tunnel diodes. (D.C.W.)

36870 INFLUENCE OF X-RAY IRRADIATIONS ON THE CHARGE DISTRIBUTIONS IN METAL-OXIDE-SILICON STRUCTURES. Kooi, E. Philips Res. Rept., 20: 306-14(June 1965).

Insulated-gate silicon field-effect transistors were irradiated by x rays. The properties of the devices altered considerably depending on the total exposure to irradiation and the gate voltage applied during the irradiation. The alterations can be explained by assuming that electric currents can flow in the MOS (metal oxide-semiconductor) system under these conditions. This causes charge redistributions, which can be locked in at the moment that the irradiation is stopped. Due to these effects MOS devices may offer certain possibilities for detection of ionizing radiations. (auth)

ISOTOPE TECHNOLOGY

General

36871 ISOTOPES AND RADIATION TECHNOLOGY. Volume 2, Number 4. Baker, P. S.; Lafferty, Robert H. Jr.; Gerrard, Martha; Fuccillo, D. A.; Greene, R. E. (eds.) (Oak Ridge National Lab., Tenn.). Summer 1965. $0.55 (GPO) (domestic), $0.70(GPO) (foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC). 49p. Dep.

Six papers are presented on the following topics: comparison of electron-beam and gamma-irradiation plants, activation analysis and its applications, and aerospace safety of isotopic and reactor power sources. Separate abstracts were prepared for three of these papers; for abstracts of the other three, see NSA 18: 31781, 37070, and 37072. An index to Volume 2 of Isotopes and Radiation Technology is included. (D.L.C.)

For abstracts of individual papers see: 36287, 36288, and 36877.

36872 II. EXPERIMENTAL STUDY OF THE ELECTRIC CHARGE OF ULTRAFINE AEROSOLS BY RADIOACTIVE MARKING. Billard, F. (Commissariat a l'Energie Atomique, Paris); Bricard, J.; Madelaine, G.; Pradel, J. J. Phys. (Paris), 26: 169A-76A(May 1965). (In French)

A study is made in a closed vessel, of the ionic equilibrium state of an atmosphere constituted by natural aerosols, with attached thoron disintegration products used as tracers. The study of radioactive particles when the equilibrium ionic state is obtained and of the attachment conditions of radioactive products by the particles is reported. (auth)

Industrial Applications

Refer also to abstracts 35884, 36239, and 36744.

36873 (KLX-1872) USE OF RADIATION TECHNIQUES FOR THE INHIBITION OF BACTERIAL GROWTH IN LIQUID MEDIA. Hellman, S. K. (Vitro Engineering Co., New York, N. Y.). July 15, 1965. Contract AT (30-1)-3331. 69p. Dep. mn; CFSTI, $3.00 cy, $0.75 mn.

An initial feasibility study of the use of low dose irradiation for inhibiting bacterial growth in liquid media is presented. The proposed technique is based on applying these low doses periodically, on a scheduled basis, so as to prevent the bacteria population from increasing, thus achieving a steady-state bacteria level over a long period of time. Although there are many applications for the use of low dose irradiation to inhibit bacterial growth in liquid media, the problem of bacteria in jet fuel wing tanks is considered for development of a conceptual irradiation unit design. The basis for the irradiation requirement of the fuel is an experimental program conducted, on a laboratory scale, at the University of Maryland's Gamma Facility. A culture Pseudomonas aeruginosa was used to prepare the simulated media. The experiments clearly indicated that control can be achieved at low dosages. However, the actual level depends on the growth rate of the bacteria and the cycle time between doses. It was possible to develop a mathematical correlation from these experiments, suitable for use as a basis for a conceptual design analysis of a commercial irradiation unit for on board treatment of fuel jet aircraft. The particular application under consideration was related to the needs of one specific airline. A conceptual design of a Mobile Fuel Irradiator (MFI) would be capable of treating the fuel in two Boeing-707 type aircraft wing tanks each night was developed. Economically, the technique was determined to be feasible. Areas needing further verification are indicated. Positive results in these experiments would implicate the design and fabrication of commercial units. (H.G.D.)

36874 (TID-21932) SIMULTANEOUS RADIATION-HEATING TREATMENT OF HADDOCK. Nickerson, John T. R.; Goldblith, Samuel A. (Massachusetts Inst. of Tech., Cambridge). [1965]. Contract AT(30-1)-3343. 32p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Bacterial types were isolated from haddock fillets, irradiated at 250,000, 300,000 and 350,000 rad and allowed to spoil while being held at temperatures of 32 or 43 to 45°F. At 32°F Corynebacterium or Microbacterium appeared to be the organisms most often causing spoilage, while at 43 to 45°F Bacillus species were most frequently isolated from spoiled products. Clostridia were never present in spoiled products in concentrations which would provide a suitable count in the 1:10 dilution, but it was possible to isolate cultures from a few black colonies on modified Mossel-Angelotti and Hall medium. Spoilage times at 32 or at 43 to 45°F were determined for haddock fillets irradiated while held at 32°F or at elevated temperatures. It was evident that for products to be stored at 32°F after irradiation, holding at 110 or 120°F during irradiation increased the storage life time as compared to product irradiated at the same dose levels while held at 32°F. When product is stored at 43 to 45°F the only significant increase in storage life appeared to be in product irradiated at 350,000 rad while being held at 120°F. The storage life of this product at 43 to 45°F was not only longer than that treated at the same dose levels while held at temperatures of 32, 100 or 110°F but was also considerably greater than any samples irradiated at 250,000 or 300,000 rad while held at either 32, 100, 110 or 120°F. Although bacterial counts indicated a distinct possibility of extending the refrigerated storage life of haddock fillets by irradiating at 110 to 120°F, as compared to irradiating at 32°F, this procedure appears not to be applicable to fresh fish such as haddock. The heating of haddock fillets to 110 to 120°F and the subsequent holding at these temperatures during irradiation causes the product to become partially or entirely cooked. This results in a partial loss of water and in significant protein changes. Haddock fillets treated in this manner are, therefore, not only difficult to handle but also can be suitably prepared for subsequent serving only by steaming or baking. While the processing method of heating marine products at 120°F or higher while irradiation at low dose levels has a definite advantage in that increased storage times at refrigerator temperatures above freezing may be attained in this manner, such a method would appear to be most effective when used for precooked products under conditions where the required radiation treatment may be applied in a reasonably short time. (auth)

36875 EFFECT OF TEMPERATURE OF LIQUID NITROGEN ON RADIATION RESISTANCE OF SPORES OF COLOSTRIDIUM BOTULINUM. Grecz, Nicholas; Snyder, O. P.; Walker, A. A.; Anellis, A. (Army Natick Labs., Natick, Mass.). Appl. Microbiol., 13: 527-36(July 1965).

An apparatus consisting of a Dewar flask and a relay system controlling the flow of liquid nitrogen permitted the irradiation of samples in tin cans or Pyrex tubes at temperatures ranging from 0 ± 1.5°C to –194° ± 2°C. An inoculated pack comprising 320 cans of ground beef containing 5×10^4 spores of Clostridium botulinum 33A per can (10 cans per radiation dose) was irradiated with ^{60}Co at 0° and –196°C. Incubation was carried out at 30°C for 6 months. Approximately 0.9 Mrad more radiation was required to inactivate the spores at –196°C than at 0°C. Cans irradiated at –196°C showed partial spoilage at 3.6 Mrad and no spoilage at 3.9 Mrad; the corresponding spoilage–no spoilage doses at 0°C were 2.7 and 3.0, respectively. The majority of positive cans swelled in 2 to 14 days; occasional swelling occurred as late as 20 days.

At progressively higher doses, swelling was delayed proportionally to the radiation dose received. The remaining nonswollen cans had no toxin after 6 months of storage, although occasional cans contained very low numbers of viable spores comprising on the average 0.1% of the original spore inoculum. The D_{10} values in phosphate buffer were 0.290 Mrad for 0°C and 0.396 Mrad for –196°C; in ground beef, the corresponding D_{10} values were 0.463 Mrad and 0.680 Mrad, respectively. These D_{10} values indicate that the lethal effect of γ rays decreased at –196°C as compared with 0°C by 13.5% in phosphate buffer, and by 47% in ground beef. (auth)

36876 DESIGN AND APPLICATIONS OF γ-RAY EXCITED X-RAY SOURCES. Watt, J. S. (Australian Atomic Energy Commission). At. Energ. Australia, 8: 6-9(Apr. 1965).

A new type of γ-excited x-ray source was developed. The main application is analysis of materials, and a number of industrial problems can be solved that previously required the more complex and expensive x-ray tube devices. Design, examples of analysis, and potential applications of γ excited x-ray sources are discussed. (auth)

36877 COMPARISON OF ELECTRON-BEAM AND GAMMA-IRRADIATION PLANTS. Artandi, Charles; Van Winkle, Walton Jr. (Ethicon, Inc., Somerville, N. J.). Isotopes Radiation Technol., 2: No. 4, 321-8(Summer 1965).

After many years of using electron accelerators to sterilize sutures and other medical products, a ^{60}Co plant was put into operation. The advantages and disadvantages of the two types of irradiators are compared with regard to source and accessory equipment. It is found that ^{60}Co sterilization offers several important advantages over accelerators. (D.L.C.)

36878 THE INFLUENCE OF ANTE-MORTEM FACTORS AND GAMMA IRRADIATION ON THE DEGRADATION OF 5′-RIBONUCLEOTIDES IN THE MUSCLE OF ENGLISH SOLE (PAROPHRYS VETULUS). Guardia, Enrique J.; Dollar, Alexander M. (Univ. of Washington, Seattle). J. Food Sci., 30: 223-7(Mar.-Apr. 1965).

Irradiation pasteurization of fish results in quantitative and qualitative changes in the associated microbiological flora. As a result, the common indices of quality for fish, TMA (trimethylamine), TVB (total volatile bases), VRS (volatile reducing substances), and TVA (total volatile acids), which are essentially measures of bacterial activity, are not entirely satisfactory when extrapolated from results obtained with unirradiated fish. Post-mortem formation of hypoxanthine in the muscle of fish is found to correlate well with freshness, even during the period preceding significant microbiological invasion. It is possible that this index of freshness could be applied to irradiated products should the enzymes involved in the degradation of nucleotides and nucleosides be unaffected by pasteurizing doses of γ irradiation. Before the hypoxanthine test of freshness could be applied readily to irradiated products, it was necessary to determine the effect of both ante-mortem and post-mortem changes upon the activity of endogenous enzymes responsible for the formation and degradation of nucleotides and nucleosides. Thus, the influence of feeding, activity, and pasteurizing doses of γ irradiation on the nucleotide composition and breakdown in English sole was studied. The samples were irradiated at 0.5 and 1.0 Mrad at 0 to 4° C in a ^{60}Co source. The samples then were stored in melting ice (0 to 1° C) for seven days. After seven days in ice, less than 10^2 to 10^3 bacteria/g were present in the sterile unirradiated or irradiated samples. Thus bacterial enzymes could not cause any significant changes to the nucleotides or nucleosides in these experiments. An ion-exchange system was used for the analysis of nucleotides. Analyses are reported for adenosine phosphates (AMP, ADP, ATP), inosine monophosphate (IMP), nicotinamide adenine dinucleotide (NAD), hypoxanthine, and inosine in irradiated and nonirradiated samples. The results indicated that pasteurizing doses of γ irradiation had no significant effect on the action of nucleotidases and nucleosidases, at least no significant effect that manifests itself in different rates of accumulation of the intermediate and final products of nucleotide breakdown. The average of the total nucleotide and nucleoside content of fed fish was 5.41 μmole/g, as opposed to 5.02 μmole/g for the unfed fish. However, this difference was not significant. At the same level, there was no difference between the average of the total nucleotide and nucleoside content of active fish (5.15) and rested fish (5.28 μmole/g). The over-all post-mortem degradation of nucleotides seemed to proceed much faster in English sole than in most other described species. This could be due to the greater activity of the 5′-nucleotidases in this species. (BBB)

36879 USE OF GAMMA-RADIATION FOR QUARANTINE CONTROL OF IMPORTED EDIBLE BEAMS. Wills, Pamela A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Nature, 206: 100-1(July 3, 1965).

The possibility of using gamma radiation for quarantine control of edible beans was investigated. The radiation dose required to destroy viability in several different varieties of imported beans was determined. The effects of radiation on various chemical constituents of the baby lima bean were also determined. The average radiation dose required to inhibit laboratory germination was about 50,000 rads. Except for a considerable decrease in sulfur-containing constituents there was little change apparent in the constituents of baby lima beans after a radiation dose of 1 Mrad. (M.C.G.)

36880 MICROSPHERICAL CARRIERS FOR RADIOISOTOPES. Ryan, J. P.; Lahr, T. H. Nucl. News, 8: No. 7, 13-15(July 1965).

Ceramic microspheres, which can completely contain or immobilize most of the useful radioisotopes, are described. The microspheres are milky-white ceramic bodies with the radioisotopes firmly bound to them. Because the microspheres are completely inert physiologically, if ingested they will simply pass through the gastrointestinal tract and be excreted. The radioisotope will not behave in a normal metabolic way, but will be retained by the microsphere, of which it is an integral part. The microspheres have an absolute density of about 3.0 g/cm and a bulk density of 2.0 g/cm^3. Their melting point is above 1500°C. The spheres are physically insoluble in almost all organic and inorganic solvents. The radioactive microspheres are prepared by sorbing the radioactive ions throughout a porous, microspherical, inorganic ion exchanger, and then fixing them therein by a heat treatment. No physical change due to self-radiation or external radiation was observed. Principal uses of these microspheres are outlined. (M.C.G.)

36881 EFFECT OF METHIONINE AND VITAMIN K_3 ON HEMORRHAGES INDUCED BY FEEDING A RATION CONTAINING IRRADIATED BEEF. Malhotra, Om P.; Reber, Elwood F.; Norton, Horace W. (Univ. of Illinois, Urbana). Toxicol. App. Pharmacol., 7: 402-8(May 1965).

DL-Methionine increases the activity of blood clotting, accelerates factors V and VII in vitamin K-deficient animals, and reduces the occurrence in rats of prolonged prothrombin time and death due to hemorrhages induced by irradiated beef. The relation between methionine and vitamin K_3 was studied as they affect the occurrence of hemorrhages and prothrombin times of male rats fed a ration containing irradiated beef (5.58 MRad). Rats were fed the 35% irradiated beef ration supplemented with 0, 0.23, or 1.37% DL-methionine for 14 weeks. Vitamin K_3 at the doses 0, 1, or 2 μg in 0.1 ml corn oil was administered to rats orally three times per week. The controls received 0.1 ml corn oil. DL-methionine linearly and significantly reduced the mortality at 4, 8, or 14 weeks, and the same was true for vitamin K_3. The mortality data suggested that there may be an interaction at 4 weeks, but it was not significant at 8 or 14 weeks. Prothrombin rates (reciprocal of prothrombin time in sec × 1000) were increased linearly and significantly as vitamin K_3 was increased. For 0.23% added DL-methionine the rate was lower, and for 1.37% it was higher, than for no supplemental DL-methionine. Prothrombin rate was normal for

rats receiving 3 μg of vitamin K_3 orally thrice weekly and 1.37% supplemental DL-methionine. DL-Methionine at 0.23% increased the body weight gains significantly. At 1.37% DL-methionine, gains decreased linearly and significantly with increasing vitamin K_3 as evidenced by a significant interaction between vitamin K_3 and DL-methionine. The results show that the prothrombin rate of the rats fed an irradiated beef ration was low. The primary cause of hemorrhage in rats fed an irradiated beef ration appears to be due to vitamin K deficiency. Since the prothrombin was decreased by irradiated beef and supplementary DL-methionine improved the prothrombin rate to normal, it is suggested that DL-methionine did not allow prothrombin activity to decrease critically. The effect of DL-methionine depended upon the quantity used. (BBB)

36882 INDUSTRIAL ISOTOPE TECHNIQUES. Erwall, Lars G.; Forsberg, Hans G.; Ljunggren, Knut. New York, John Wiley and Sons, Inc., 1965. 340p. $19.50.

Technical uses of radioisotopes are discussed under the following headings: atomic nuclei and nuclear radiation; nuclear chemistry and isotope production; measurement of nuclear radiation; technical use of nuclear radiation sources; industrial tracer techniques; radioactive methods in analysis; and radiation protection in industrial use of radioisotopes. (F.J.H.)

36883 RADIATION PRESERVATION OF FOODS—PRESENT STATUS AND FUTURE OUTLOOK. Goldblith, Samuel A. (Massachusetts Inst. of Tech., Cambridge). pp 263-70 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965.

A great deal of progress has been made, particularly in the United States, within the past twelve months on the radiation preservation of foods with respect to the wholesomeness aspects. Bacon has been approved by the U. S. Food and Drug Administration for treatment with either gamma rays from cobalt-60 or electrons producted by an accelerator at energy levels up to 5 Mev. A regulation has been published permitting the use of cobalt-60 gamma rays for the deinfestation of wheat. Petitions have been filed with the U. S. Food and Drug Administration for sprout inhibition of wheat and potatoes and for the inhibition of microorganisms in citrus fruits. It is expected that a petition will be filed requesting that a regulation be written to permit the preservation of chicken by irradiation. The rationale of the entire wholesomeness program in the United States and the present status of radiation preservation and radiation sterilization, as well as considered opinions on the future of this field in the United States and in other parts of the world are discussed. (auth)

36884 GAMMA-RADIATION PRESERVATION OF POTATOES. Perdomo, M. A.; Hernandez, J. A.; Sanin, S. J. (Instituto de Asuntos Nucleares, Bogota). pp 277-83 of 5th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Washington, D. C., Pan American Union, 1965. (In Spanish).

Potatoes (Solanum andigenum), of the varieties Tocarreña and Pardo Pastusa were irradiated with cobalt-60 gamma rays for the purpose of increasing their safe storage time and studying the effects of gamma radiation in doses of 5, 7.5, 10, and 15 kilorads at a rate of 860 rads per hour per meter. The samples, including controls, were stored for 8 months at a temperature of 10 ± 2°C. Determinations were made of starch, inverted sugars, reducing sugars, ascorbic acid, loss of weight, flavor, color, and texture in samples stored 0, 3, and 8 months. The results show that radiation under the conditions observed does not produce unfavorable changes in the quality of the product. At the end of the test, 8 months, the control samples had germinated considerably and were valueless for consumption, while the samples irradiated with 7.5 or more kilorads were in good condition. The optimum dose for an 8-month preservation period appears to be close to 10 kilorads for both varieties, with the Pardo Pastusa variety behaving better. (auth)

Power Application

36885 (LA-3278) SATELLITE HEAT PIPE. Deverall, J. E.; Kemme, J. E. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Jan. 1965. Contract W-7405-eng-36. 21p. Dep.; $2.00(cy), 1(mn) CFSTI.

A heat pipe was developed which will be used in a satellite to transfer heat isothermally from an externally mounted radioisotope to the electronic component section. The purpose of this system is to reduce the amplitude of temperature cycling of the components when in orbit. The heat pipe is stainless steel with water as the working fluid. Heat from the isotope capsule is transferred to the pipe through an aluminum block assembly. Stainless steel clamps hold the capsule in position and supply the necessary pressure for good thermal contact. This arrangement provides for simple removal of the isotope for shipping. Several test models were built and tested using electric heaters to simulate the isotope heating. A satisfactory design was developed which will transfer more than 90% of the isotope heat to the required zone. (auth)

36886 (MND-3169-16) SPECIFICATION FOR PLASMA ARC TESTS OF SNAP-19 FUEL CAPSULES. Weber, W. B. (Martin Co., Baltimore, Md. [Nuclear Div.]). [1963]. Contract AT(30-1)-3169. 24p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A plasma arc test program for Ta fuel-capsule liners is established that will result in an empirical definition of the ablation rate of thin-wall Ta cylinders as a function of stagnation enthalpy, stagnation pressure, and stagnation heat flux. (auth)

Separation and Production

See *also* CHEMISTRY — Separation Processes and Procedures.

Refer also to abstract 37328.

36887 (AEET-204) SEPARATION OF NEON ISOTOPES BY THERMAL DIFFUSION. [PART] I. Raman, S.; Narayanan, T. K. S.; Dave, S. M. (Atomic Energy Establishment, Trombay (India)). 1965. 21p. Dep.(mn).

The thermal diffusion factor for neon was determined at the mean temperature of 243°K, using a glass swing separator. A comparison with the literature data and theoretical values was done. (auth)

36888 (AEET-205) SEPARATION OF NEON ISOTOPES BY THERMAL DIFFUSION. [PART] II. Raman, S.; Narayanan, T. K. S.; Dave, S. M. (Atomic Energy Establishment, Trombay (India)). 1965. 20p. Dep.(mn).

The performance of a hot-wire thermal diffusion column is discussed. It has been found that equilibrium is approached within an hour with neon. Maximum separation is obtained in this column at a pressure of 42 cm of mercury. Use of two spacers to centralize the hot-wire increases the separation. (auth)

36889 (MLM-1250) MOUND LABORATORY PROGRESS REPORT FOR MARCH 1965. Eichelberger, J. F.; Grove, G. R.; Jones, L. V. (Mound Lab., Miamisburg, Ohio). Mar. 31, 1965. Contract AT(33-1)-Gen-53. 35p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The standard electrode potentials of the half cells Po = Po(II) + $2e^-$ and Po(II) = Po(IV) + $2e^-$ in HCl were determined to be 0.510 and 0.712 volt, respectively. The first oxidation step in HCl leads to the complex $PoCl_4^{=}$, and the second oxidation step probably forms $PoCl_6^{=}$. The potential measurements were carried out using a mixture of ^{208}Po and ^{209}Po. The isotopic mixture has a specific activity of about 4% of that of ^{210}Po. X-ray diffraction studies of alpha-phase $^{208}Po/^{209}Po$ showed that this phase exhibits stability for periods of eight weeks or more at approximately 23°C.

Gamma counting of ^{239}Pu samples was continued in an effort to determine the parent isotope of the hard gamma impurities. Calculations showed the disintegration rate ratio of $^{234}U/^{233}U$ could be used to determine the impurity parent isotope. Calculation results from three different ^{234}U samples indicate the parent isotope was ^{236}Pu. The anion exchange behavior of U in carbonate media was examined for possible inclusion in the ^{234}U recovery scheme. Good loading was observed and HNO_3 elution following a bicarbonate wash proceeded without difficulty. The compound $K_4Pu(SO_4)_4 \cdot 2H_2O$ is being evaluated as a primary calorimetric standard for ^{239}Pu. A sample of PuO_2 was fused with potassium pyrosulfate; the melt was dissolved in H_2SO_4 and filtered. The solution was concentrated by evaporation to precipitate potassium plutonium sulfate. Reprecipitations are being carried out to reduce the amount of plutonium sulfate which had coprecipitated with the product. The decay of ^{228}Fr is being investigated. The half-life of the ^{223}Fr obtained agrees with previous values. Calorimeter measurements of PuBe source M-1127 were completed. The growth rate was determined to be 1.6 ± 0.1%/year. In thermal diffusion research processes to account for the lack of material balance of ^{13}C in the transport are being studied. The impurities at the bottom of the methane cascade were separated and analyzed to determine their origin. Approximately 0.5 g ^{13}C in methane, 93 to 94% mass 17 enrichment, was produced from the 12-column, 8-stage thermal diffusion cascade. Efforts to compensate for (rather than decrease) methanol vapor losses in the carbon dioxide-carbamate chemical exchange system were unsuccessful. Analyses of the decomposed carbamate solution following completion of a run showed 1.60% CO_2 still present. The liquid He freeze-out chamber reduced the tritium content of product ^3He to less than 2×10^{-10}% after recharging with activated charcoal. The ^{20}Ne product rate was decreased at the top of the 96-ft thermal diffusion cascade so that 100% ^{20}Ne could be removed. The ^{20}Ne and ^{22}Ne product concentrations were ≥99.98% and >99.56%, respectively, at flow rates of 120 ml/hr and 14 ml/hr. Increase of the ^{36}Ar product rate raised the ^{38}Ar peak and transport so that the ^{38}Ar concentration at the top fourth of the cascade reached 2.4%. The last run of the first pass for enriched ^{84}Kr and ^{86}Kr is being made before the second pass is started to enrich the ^{86}Kr to 40%. Data are being obtained to determine the heats of absorption of Xe and Kr on Linde Molecular Sieve 4A. At 166 to 243°K retention times were brief and temperature independent. A 15-g quantity of O_2 depleted in the rare isotopes ^{17}O and ^{18}O was prepared by thermal diffusion. A motor-drive unit for the detector slit of the molecular beam scattering apparatus was placed in operation, and several runs were made using the drive to move the detector slit across the beam. The angular resolution of the apparatus was found to be 7.0 minutes of arc for a total detector intensity fluctuation of 0.01%. Measured static separation factors for ^{20}Ne and ^{22}Ne in the 6-ft experimental column were about 15% greater than those predicted from theory. A working equation was derived for a two-bulb thermal diffusion apparatus which is designed such that the method of multiple separations can be used when the volumes of the two bulbs are unequal. An error analysis of this equation indicates that the use of this apparatus for measuring low-temperature thermal diffusion factors is feasible. A simplified version of an earlier constant current controller was constructed which compensates for the drift in Willard low-discharge batteries to 8 ppM/8 hr. The current range is 1 to 100 milliamperes. The procedure for liquid scintillation counting of tritium in ^3He and ^{85}Kr in Xe was modified by introducing the sample and scintillator solution into the counting vial with hypodermic syringes through self-sealing rubber serum stoppers. Counting efficiencies of approximately 20% and 80% for tritium and ^{85}Kr, respectively, were obtained. Erratic behavior of Geiger tubes used in internal gas counting of tritium in ^3He was corrected by increasing the quenching gas in the counting tubes, thus counteracting effects of impurities built up over a period of time in components of the vacuum systems and Geiger tubes. High-level tritium determinations are being made by bremsstrahlung counting. Results are consistent to within 2% of statistical fluctuations. Preliminary investigations indicate that it would be feasible to determine the isotopic content of ^{10}B in elemental B by utilizing the large thermal neutron absorption cross section of ^{10}B. In this method the decrease in neutron flux across a $\frac{1}{16}$-in. air gap is measured; then the gap is filled with powdered elemental B, and the neutron absorption is measured. The neutron absorption is a weight dependent function of the ^{10}B present. A procedure for the simultaneous determination of U, Fe, and Ni is being investigated by controlled potential coulometry; preliminary results appear favorable in the analysis of U–Fe solutions. A series of measurements are being made to determine the effects of a terphenyl phosphite on the shrinkage of an epoxy adhesive formulation. As the concentration of this reactive diluent was increased in the formulation, shrinkage decreased and gel time increased. (J.R.D.)

36890 (JPRS-30769) RADIOACTIVE ISOTOPE PRODUCTION DEVELOPMENT AT THE BORIS KIDRIC INSTITUTE IN VINCA. Draskovic, Rade. Translated from Tehnika (Belgrade), No. 4, 650-2(Apr. 1965). 10p. (TT-65-31325). CFSTI, $1.00 cy.

A brief account is given of the radioisotope production program. The problems that occurred in the program and their solution are described. The yearly production of radioisotopes and the field in which they were used are tabulated. (D.L.C.)

36891 (JPRS-30771) YUGOSLAV RADIOACTIVE PRODUCTS FOR INDUSTRIAL USES. Teofilovski, Cedomir. Translated from Tehnika (Belgrade), No. 4, 644-9(Apr. 1965). 17p. (TT-65-31327). CFSTI, $1.00 cy.

The research reactor RA at Vinca and its use for radioisotope production are discussed. A survey is presented of the domestic production of radiation sources and radioisotopes. The following types of sources are covered: sources for manufacturing control devices, radiographic sources, powerful ^{60}Co sources, and radioactive solutions. Possibilities for further development of the domestic radioisotope production are considered. (D.L.C.)

36892 CERTAIN POSSIBLE METHODS FOR PRODUCING RADIOACTIVE ISOTOPES. Rudenko, N. P.; Sevast'yanov, A. M. At. Energ. (USSR), 18: 649-50 (June 1965).

Production of ^7Be, ^{28}Mg, and ^{26}Al in nuclear reactors as a result of secondary reactions of $^6Li(t,2n)^7Be$, $^{26}Mg(t,p)^{28}Mg$, and $^{24}Mg(t,n)^{26}Al$ is described. The ampoules containing metallic lithium or lithium compounds (for preparing ^7B) and lithium with magnesium (for preparing ^{26}Al and ^{28}Mg) were irradiated by integral neutron flux (~10^{20} neutr/cm^2 for ^{26}Al and ^7Be and 6.5×10^{16} neutr/cm^2 for ^{28}Mg). The spectrum is given of γ emission from irradiated Li–Mg recorded in a 50 channel amplitude analyzer. Another method of production of ^{10}Be and ^{26}Al by irradiation of Be, B, Mg, and Al by fast neutrons and for boron and magnesium by thermal neutrons is described. The identification of ^{10}Be was achieved by β emission energy. (R.V.J.)

36893 GAMMA-SPECTROMETRIC DETERMINATION OF THE PURITY OF SOME TARGET MATERIALS FOR THE PRODUCTION OF MEDICAL RADIOACTIVE ISOTOPES. Nikolov, K.; Popov, Kh.; Tomov, T. Izv. Fiz. Inst. s Aneb, Bulgar, Akad. Nauk, 13: 175-84(1965). (In Bulgarian)

The methods worked out for the gamma-spectrometric determination of the purity of target materials designed for the production of six radioactive isotopes for medical purposes are described. The samples were irradiated with thermal neutrons with a density of about 7×10^{12} n cm^{-2} sec^{-1} of the IRT-1000 nuclear reactor in Sofia. The time of irradiation varied from 5 min to the length of the production activation of each of the corresponding isotopes. The identification of the radioactive contaminants was achieved by determining the energy of gamma radiation and the periods of half-decay of the characteristic

peaks. A formula was deduced for the calculation of the radioactive isotopes—contaminants (gold-199 and tantalum-183) which accumulate as a result of the partial "burning" of the initially formed isotopes in the targets irradiated. (auth)

36894 ON THE CASCADE THEORY OF THE SEPARATION OF POLYNARY ISOTOPE MIXTURES. Narten, Alfred (Oak Ridge National Lab., Tenn.). Z. Naturforsch., 20a: 663-6(May 1965). (In German) (ORNL-P-1046)

The theory of isotope separation in cascades is extended to polynary mixtures. Conditions for minimum reflux (maximum production) are derived. For square cascades, the general solution of the differential equations is indicated; a special solution is given for the important case of large reflux ratio. The enrichment of middle components in ternary mixtures is discussed, it is shown to be impractical in a single square cascade. (auth)

36895 MASS-SEPARATION INSTALLATION WITH CROSSED MAGNETIC AND ELECTRIC FIELDS FOR PRODUCING PURE (C > 99%) RARE ISOTOPES OF HEAVY ELEMENTS. Dmitruk, M. I.; Malov, A. F.; Panin, B. V.; Runov, A. D.; Soldatov, A. F.; Shchepkin, G. Ya. p.47-70 of "Fizicheskaya Elektronika. Vypusk 2." Moscow, Atomizdat, 1965. (In Russian)

The isotopes of most elements are separated in single-stage electromagnetic equipment, but the enrichment coefficient is rarely greater than 400 to 500. Isotopes that occur in low percentages can not be obtained in high purity in this equipment because of the low efficiency, and a multi-stage system has been proposed. The theory of a two-stage system is developed mathematically, and the equipment is described. Experimental results showed that such equipment is suitable for separating small amounts of isotopes of greater than 99% purity, even of those of the heavy elements that occur in small amounts. The equipment may also be used for detecting and determining very small amounts of isotopes and impurities in samples. Lead-204, which occurs in natural lead only to the extent of 1.5%, was 99.6% in the product of a two-stage operation. A sample of cadmium was enriched to 99.9% in ^{114}Cd. (TTT)

36896 METHOD OF PRODUCTION AND EXTRACTION OF IODINE-131. Hatzopoulos, Elie (to Commissariat a l'Energie Atomique). U. S. Patent 3,179,568. Apr. 20, 1965. Priority date Mar, 7, 1962, France.

A method is described for the production and extraction of iodine-131 from a tellurium oxide or telluric acid that has been exposed to neutron irradiation at a temperature of from 50–120°C. After irradiation, the resulting compound is precipitated in an aqueous solution of an alkaline earth as an iodine-containing salt. Heating serves to crystallize the voluminous, amorphous precipitate and to liberate the iodine into solution. Prior to recovery of the iodine by distillation an entrainer selected from the group consisting of alkali metal iodides, iodates, or periodates is added and the solution is acidified. (B.L.M.)

36897 METHOD FOR COOLING OF CIRCULATING GAS IN A PLANT FOR ENRICHMENT OF HEAVY WATER. Eriksson, Bengt (to Aktiebolaget Atomenergi). U. S. Patent 3,188,177. June 8, 1965. Priority date Apr. 16, 1958, Sweden.

Hydrogen sulfide gas circulating in a plant for enrichment of heavy water by isotope exchange between the gas and water at two different temperatures is cooled by a cold water stream in countercurrent direct contact with the gas. Undesirable evolution of heat caused by absorption of gas in the water is prevented by cooling the water in the presence of supplied hydrogen sulfide so that the cold water is saturated when it contacts the gas stream and no further absorption takes place. (A.G.W.)

36898 HELIUM REFINING BY SUPERFLUIDITY. Hildebrandt, Alvin F. (to National Aeronautics and Space Adm.). U. S. Patent 3,192,730. July 6, 1965. Filed Feb. 5, 1963.

In a process for producing ultra-pure He, the He is brought to a temperature below the lambda point at 2.19°K and passed through a filter. A suitable filter consists of compacted iron oxide particles of about 10–15 μ. Almost all impurities are solids at this temperature and are blocked by the fine pores between the iron oxide particles. The method may also be used to separate ^3He from ^4He since ^3He flows through the filter much more slowly than ^4He. (A.G.W.)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 36144, 36145, 37264, 37777, 37778, and 37902.

36899 (ANL-7022) COGENT—PROGRAMMING MANUAL. Reynolds, John C. (Argonne National Lab., Ill.). Mar. 1965. Contract W-31-109-eng-38. 116p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

An initial version of the COGENT system was previously written for the Control Data 3600 computer. This manual is intended primarily to describe the input language for this system; operating procedures and details of the specific machine implementation are not discussed. (M.O.W.)

36900 (K-1633) BIASES AND COVARIANCES OF MAXIMUM LIKELIHOOD ESTIMATORS. Bowman, K. O. (Oak Ridge Gaseous Diffusion Plant, Tenn.); Shenton, L. R. (Oak Ridge National Lab., Tenn.). May 19, 1965. Contract W-7405-eng-26. 24p. Dep.; $2.00(cy), 1(mn) CFSTI.

A population consisting of a denumerable set of classes is considered, the probability of an occurrence in the j th class being $p_j(\theta_1, \theta_2, \ldots, \theta_k)$. For the maximum likelihood estimates $(\hat{\theta}_1, \hat{\theta}_2, \ldots, \hat{\theta}_k)$ of the parameters $(\theta_1, \theta_2, \ldots, \theta_k)$ in a random sample of a size N are given the N^{-2} terms in the asymptotic expansions of the variances and covariances in terms of expectations of products of derivatives of $\log p_j$. As an application the estimation of the parameter λ and α for a negative binomial distribution (mean λ and variance $\lambda + \lambda^2/\alpha$) is considered. This includes the second-order terms in Var $\hat{\alpha}$ and $E\hat{\alpha}$ and the first order correction term in the generalized efficiency of the method of moments (using the estimators $\lambda^* = m_1'$, $\alpha^* = m_1'^2/m_2 - m_1'$), where m_1' is the sample mean, m_2 the sample second central moment). (auth)

36901 (K-1643) ASYMPTOTIC COVARIANCES FOR THE MAXIMUM LIKELIHOOD ESTIMATORS OF THE PARAMETERS OF A NEGATIVE BINOMIAL DISTRIBUTION. Bowman, K. O. (Oak Ridge Gaseous Diffusion Plant, Tenn.); Shenton, L. R. (Oak Ridge National Lab., Tenn.). July 1, 1965. Contract W-7405-eng-26. 151p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

The parametric form considered for the binomial distribution has mean value kp and variance kp(1 + p), where k, $p > 0$. The first order covariances of $\hat{k}$, $\hat{p}$, the maximum likelihood estimators of k and p respectively, are given as elements in the inverse of the covariance matrix. These covariances are asymptotic expressions in the sample size n and are only valid in so-called large sample theory. To determine in a rough way how large n must be for the first order covariances to be approximately correct, the second order terms are evaluated and tabulated. From these an indication of the sample size needed to place some confidence in the traditional asymptotic formulas is worked out. The results show that very large sample sizes may be required when k and p are both small. A similar study of another commonly used parametrization is given. The results have a bearing on the efficiency in joint estimation of the moments method. (auth)

36902 (KAPL-M-6429) COMP1, A DATA COMPARISON PROGRAM FOR THE PHILCO-2000. Kopp, H. J.; Brooks, E. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 1964. Contract W-31-109-eng-52. 31p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The COMP1 program is a FORTRAN II program for the Philco-2000 which was developed to compare one-dimensional arrays. A typical application would be the comparison of a set of experimental data with a set of theoretical predictions. Percentage differences and ratios may be calculated. Both tabular and graphical output is generated by the program. (auth)

36903 (KAPL-M-6456) DOGGY—A PROGRAM TO PERFORM MATHEMATICAL FORM SHEET CALCULATIONS. Gazda, Sally A. (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar. 5, 1965. Contract W-31-109-eng-52. 33p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

DOGGY is a computer program that can perform most routine form sheet calculations. The program is capable of handling common algebraic manipulations on columns of input such as addition, subtraction, multiplication, and division. DOGGY also has provision for use of special functions such as logarithmic, trigonometric, arc trigonometric, hyperbolic, exponential, square root, maxima, minima, and raising a number to any power. Thermal property of water calculations is also among the 50 permissible DOGGY operations. The approximate running time is very problem dependent but rarely exceeds 2 minutes per case. DOGGY is currently limited to 150 columns of input with 100 rows per column. DOGGY is an updated combination of the two former KAPL form sheet calculation programs, MPD and DOGY. (auth)

36904 (LA-3292) A FORTRAN VERSION OF NORDSIECK'S SCHEME FOR THE NUMERICAL INTEGRATION OF DIFFERENTIAL EQUATIONS. Lewis, H. R. Jr.; Stovall, E. J. Jr. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Mar. 1965. Contract W-7405-eng-36. 36p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Modifications of Nordsieck's scheme for numerically integrating differential equations are described, which permit satisfactory operation in floating-point arithmetic. The major modification, recommended for both fixed-point and floating-point operation, is a reformulation of the test for numerical stability. Also discussed, in relation to the floating-point scheme, is Nordsieck's use of guard digits and novel rounding techniques. A computer subroutine for the modified scheme is presented in the FORTRAN-II and FORTRAN-IV languages. (auth)

36905 (NAA-SR-Memo-9623) GLAD—(GAUSSIAN AND LORENTZIAN, ABSORPTION AND DERIVATIVE CURVES). Medeiros, Katharine W.; Young, W. A. (Atomics International, Canoga Park, Calif.). Mar. 1964. Contract AT-11-1-GEN-8. 80p. Dep.(mn); $3.00(cy), 2(mn) CFSTI

A code which calculates analytically and plots, in optional combinations, graphs of Gaussian and Lorentzian absorption and derivative curves is described. (auth)

36906 (NAA-SR-Memo-9624) GOLD—(GAUSSIAN OR LORENTZIAN DERIVATE CURVES). Medeiros, Katharine W.; Young, W. A. (Atomics International, Canoga Park, Calif.). Mar. 1964. Contract AT-11-1-GEN-8. 50p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A code which calculates and plots, using the SC-4020, the sum of the derivatives of Lorentzian functions, Gaussian functions, or both is described. (auth)

36907 (ORNL-3742(Rev.)) A GENERALIZED ONE-CONSTRAINT LAGRANGE MULTIPLIER NUMERICAL FORMULATION. Clark, F. H. S.; Kam, F. B. K. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 46p. Dep.; $3.00(cy), 1(mn) CFSTI.

The one-constraint Lagrange multiplier problem was written for the CDC-1604 computer in a FORTRAN program called MAX. The program can deal with a combination of any varied and any constraining function which depends on no more than 18 independent variables and for which all second derivatives exist throughout the domain. The user is required to write two sub-routines: one defines the varied function, the other, the constraining function. The computational method used is absolutely nondivergent, but for some starting values in some problems it will stop in the neighborhood of an extraneous point and require a restart at a different point. A test problem is included. (auth)

36908 (ORNL-P-1303) TWO ALGORITHMS OF ROMBERG TYPE FOR ORDINARY INITIAL-VALUE

PROBLEMS. Gragg, William B. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 5p. (CONF-650505-3) Dep.(mn), $1.00(cy), 1(mn) CFSTI.

From IFIP Congress 1965 Meeting, New York.

The existence of simple discretizations of both first and special second order systems, which have an asymptotic expansion in powers of h^2, is shown. Two algorithms of Romberg type are obtained. (M.O.W.)

36909 (UCRL-14177) FORMULA MANIPULATION CODE FOR THE CALCULATION OF CHRISTOFFEL SYMBOLS. Walton, John J. (Lawrence Radiation Lab., Univ. of California, Livermore). May 5, 1965. Contract W-7405-eng-48. 41p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The IBM FORMAC compiler was used to write a program capable of calculating various quantities of interest in tensor calculus. With this code Christoffel symbols of the first and second kind were calculated for 12 basic orthogonal coordinate systems. (auth)

36910 INVARIANT EXPANSIONS OF RELATIVISTIC AMPLITUDES AND SUBGROUPS OF THE PROPER LORENTZ GROUP. Winternitz, P.; Fris, I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 889-901(May 1965). (In Russian)

All the conjugated classes of continuous subgroups of the proper Lorentz group are found. Their invariants are investigated, and the question of their connection with coordinate systems in which the variables in the Laplace equation in the Lobachevsky space separate is considered. A simpler example of the group of motions of a Euclidean plane is considered in order to clarify the group theoretical properties of elliptic coordinates. (auth)

36911 AUTOMATIC ACQUISITION AND REDUCTION OF NUCLEAR DATA. Proceedings of a Conference Organized by European-American Nuclear Data Committee in Collaboration with Gesellschaft fuer Kernforschung mbH, Karlsruhe, July 13-16, 1964. Beckurts, K. H.; Glaeser, W.; Krueger, G. (eds.). Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964. 580p. DM 15.-; $3.75. (CONF-593)

Sixty-five papers are included; separate abstracts were prepared for 56. Eight papers were previously abstracted for NSA; see 18: 32019, 18: 33876, 18: 34366, 18: 39624, 18: 43938, 18: 44023, 19: 4523, and 19: 21731. (L.B.S.)

For abstracts of individual papers see: 36778, 36779, 36780, 36781, 36782, 36783, 36784, 36785, 36786, 36787, 36788, 36789, 36790, 36791, 36792, 36793, 36794, 36855, 36912, 36913, 36914, 36915, 36916, 36917, 36918, 36919, 36920, 36921, 36922, 36923, 36924, 36925, 36926, 36927, 36928, 36929, 36930, 36931, 36932, 36933, 36934, 36935, 36936, 36937, 36938, 36939, 36940, 36941, 36942, 36943, 37633, 37776, 37777, 37778, 37902, and 38088.

36912 GENERAL SURVEY: AUTOMATIC DATA HANDLING IN LOW ENERGY NUCLEAR PHYSICS. Lidofsky, L. J. (Columbia Univ., New York). pp 9-25 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The steps in automating data processing systems, which are primarily concerned with improving the link between the data taking station and the computer, are discussed. General techniques employed in data acquisition and processing in low-energy physics are outlined, and an illustration is given of some features of a measurement to determine the probability of gamma coincidences. The advantages afforded by storage of data by direct input into a computer are considered together with various types of computer systems and their capabilities for experiments characterized by the data rates in low-energy physics. Diagrams are presented of data processing systems with no direct data link, with a data link between multichannel analyzer and computer, and an automatable data acquisition and treatment center with direct data link and data link between multichannel analyzer and computer. (L.B.S.)

36913 GENERAL SURVEY: AUTOMATIC DATA HANDLING IN HIGH ENERGY PHYSICS. Kowarski, L. (Purdue Univ., Lafayette, Ind.). pp 26-40 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The processing of visual data from bubble and spark chamber experiments is discussed. The processing chain of the present human-based system is analyzed into its component phases. The development and application of the scanning and measuring projector and the flying spot digitizer for limited automation in data processing are discussed. Developments in full automation for processing of bubble and spark chamber pictures are also discussed together with consideration of the use of television cameras for filmless processing. The consequences of automation in high-energy physics are noted. (L.B.S.)

36914 GENERAL SURVEY: STATUS AND IMMEDIATE FUTURE OF COMPUTER DEVELOPMENT FOR NUCLEAR PHYSICS APPLICATIONS. Miller, W. F. (Argonne National Lab., Ill.). pp 41-50 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The status of developments toward the automation of a research laboratory is presented. The developments in computer hardware, software, and techniques for applications to fast calculations, information storage and retrieval, switching and control, and symbol manipulation are discussed. (L.B.S.)

36915 GENERAL SURVEY: FIXED WIRED MULTICHANNEL ANALYZERS. Fiebiger, N. (Universitaet, Frankfurt am Main). pp 53-8 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The advantages and disadvantages of fixed-wired multiparameter analyzers are pointed out, and a comparison is made with stored-program analyzers. The problems of the fixed-wired systems which are connected with its memory and the restrictions forced upon its organization are considered. A brief account is given of the available fixed-wired systems along with some of the general specifications. The use of the analyzers in combination with computers is discussed. (L.B.S.)

36916 EXPERIENCE WITH WIRED PROGRAM ANALYZER WITH TWO-WAY LINK TO OFF-LINE COMPUTERS. Goodman, C. D. (Oak Ridge National Lab., Tenn.). pp 59-64 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

Large memory, wired program analyzers have been used in nuclear reaction experiments and in radioactivity experiments. The analyzers include displays in which a contour map and profile can be examined simultaneously on two cathode ray tubes. Among the nuclear reaction uses is the acquisition of correlated dE/dx-E pulse height data where several types of particles are involved. The analyzer is used also for recording simultaneously the spectra from 32 counters placed at different angles in a polarized proton scattering experiment. The immediate availability of the data for detailed examination on the display has been found to be of great value. Processing of the data is done on IBM 7090 and CDC 1604 computers linked to the analyzers by way of magnetic tape. Computer output can be read into the analyzer memory from magnetic tape so that the results of computation can be compared with data on the display. The analyzers have also been used as conventional pulse height analyzers. In this application enough memory exists to store fifty 400-channel spectra. The memory plane can be selected manually. The automatic sequencing is useful for taking spectra in rapid succession for following short half-lives. The availability of all the spectra for immediate examination makes this analyzer desirable even when its multiparameter capabilities are not used. Attachment of the analyzer to auxiliary equipment is easy. Control function sequencing is modified through patch panel connections. (auth)

36917 A MULTIPLE INPUT DIGITAL ANALYZER WITH DIRECT ACCESS TO COMPUTER MEMORY.

Schneider, H. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 65-72 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A digital analyzer was constructed with which data from up to eight 1024 channel pulse-height encoders or similar devices may be processed and stored directly in a special 8k memory extension of the CRNL Electronic Data Analyzing Centre computer. The eight inputs are scanned at a 2.5 Mc/s rate while the read-out to the computer memory is 150 Kc/s (max.). A four register buffer store acting as a derandomizer is included to allow higher input rates without exessive counting losses due to the relatively slow read-out rate. At intervals when no data is being processed and the central processor of the computer is not using the special memory, addresses are scanned successively and their contents transferred to remote display control units, allowing live display to be associated with each encoder. (auth)

36918 RECENT PROGRESS IN DATA PROCESSING BY THE MULTIPARAMETER ANALYZER AMF 1. Avril, M.; Pages, A. (Centre d'Etudes Nucleaires, Saclay, France). pp 73-8 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The operation and performance of the Saclay multiparameter analyzer are examined along with the problems raised by the multiple functions of the analyzer (28 digits or more). A comparison is made between the AMF 1 type analyzer and the small computer. Various types of pretreatment units and interconnectors are also examined. (L.B.S.)

36919 A COMPUTER FACILITY FOR TOTALIZING AND REDUCTION OF MAGNETIC TAPE DATA. McConnell, D. B. (United Kingdom Atomic Energy Establishment, Harwell, Berks, Eng.). pp 100-3 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A PDP-4 computer system for analysis and simple processing of recorded time of flight data is described. The factors important to the choice of the particular computer are treated: input/output hardware, analysis and computation times, available programming languages, and cost of each computer system. Some problems encountered with this system, and our solutions to them, are given. Future plans for the facility are discussed. (auth)

36920 GENERAL SURVEY: THE USE OF COMPUTER SYSTEMS FOR DATA ACQUISITION. Norbeck, E. (Univ. of Iowa, Iowa City). pp 122-31 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A diagram is presented of the University of Iowa multiparameter system, which uses magnetic tape storage with a small digital computer. The operation and performance of the data acquisition system are discussed and illustrated by isometric pictures obtained from the display scope of the spectra from the $^{7}Li + {}^{4}Be$ reaction. (L.B.S.)

36921 EXTENSIVE EXPERIENCE WITH AN ON-LINE COMPUTER IN A NUCLEAR LABORATORY. Meadows, J. W.; Whalen, J. F.; Smith, A. B. (Argonne National Lab., Ill.). pp 132-42 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A multiparameter system for the storage and analysis of data in a low energy nuclear laboratory was constructed. Digital arithmetic functions, storage, and control are exercised by a CDC-160A computer. The logic and the design of this apparatus (including input-output devices) are described. Examples of on-line fission and fast neutron experiments taken from 18 months of successful operations are given. (auth)

36922 ON-LINE COMPUTER EXPERIENCE WITH THE CHALK RIVER TANDEM ACCELERATOR. Broude, C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 143-8 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The on-line computer facility at the Chalk River tandem accelerator consists of a PDP-1 processor which has operated with 8K of memory during its initial period of use. The processor is equipped with a 16 channel sequence break system. In addition to the standard in-out equipment, two 100-channel and one 900-channel pulse height analysers can be read into the computer memory. Further, eight 18 bit input buffers can accept information from eight 400 channel analogue-to-digital converters. These ADC's provide for a very flexible system of data accumulation via the sequence break system. The programming system allows a short data acquisition program written for a specific experiment to be embedded in the general spectrum handling routine which occupies 4K of memory. The other 4K is available for data storage. Many configurations of the ADC's have been used to meet the requirements of individual experiments. The event by event manipulations which have been performed by the computer include logical sorting of events according to digital windows set on spectra, digital addition of pulse height information from two detectors in time coincidence to produce sum spectra, and the numerical stabilization of spectra. The future development of the system is described. (auth)

36923 A DESCRIPTION OF THE PHYLIS ON-LINE COMPUTING SYSTEM. Vonderohe, R. H.; Gemmell, D. S. (Argonne National Lab., Ill.). pp 156-63 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The PHYLIS computing system is currently being used on line at Argonne National Laboratory in conjunction with low energy nuclear physics. The system processes data acquired at the 12 Mev Tandem generator and at the 4.5 Mev Van de Graaff generator. The central processor for the system is an ASI 2100 computer with a 2 microsecond memory cycle time. Peripheral equipments attached to the ASI 2100 include both standard and special purpose devices. The standard devices include magnetic tape units, line printers, card processing equipment, typewriters, a digital plotter, etc. The special purpose equipments are: a data link to the Tandem generator site incorporating a two-parameter, 4096 channel pulse height analyzer, which permits two-directional access to the pulse height analyzer memory and output from the two ten-bit ADC's; a communication link to a large computer (CDC 3600) allowing rapid word communication; and a data link to the 4.5 Mev Van de Graaff site. The system will be enlarged in the near future with the addition of a 16-inch display oscilloscope. A light pen operated in conjunction with the oscilloscope will permit rapid operator feed-back to the computer for purpose of display modification and data input to analysis programs. (auth)

36924 TWO PARAMETER ANALYZER AND OTHER USE OF A DIGITAL COMPUTER IN A NUCLEAR LABORATORY. Barnard, A. C. L.; Keyes, R.; Buchanan, J. A.; Rabson, T. A.; Phillips, G. C. (Rice Univ., Houston, Tex.). pp 170-3 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A brief discussion is presented on the use of an IBM 1401 computer for fast acquisition and delayed time processing of two-parameter experimental data, for fast readout and processing of data from commercial analyzers, for single-parameter applications, and for general purpose computing of nuclear problems. (L.B.S.)

36925 DESIGN OF A DATA-HANDLING SYSTEM WITH A CAE-510 COMPUTER FOR MULTIPARAMETRIC ANALYSIS. Bianchi, G.; Corge, C. R.; Meinadier, J. P. (Centre d'Etudes Nucleaires, Saclay, France). pp 174-83 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

Design and programing considerations are given for a

data-handling system built around a CAE-510 computer. Digital information can be fed directly into the machine from any point of a functional multiparameter analyser, i.e., either from the derandomizer unit, working conditions being real-time ones, from the 16-track magnetic tape on which all parameters are recorded per event, from the conditioning unit which selects a different batch of codes at each play back, or from the totalizing 4096 channel core memory. The system is provided with usual peripheral equipment and different displays. The most valuable one is a cathode ray tube which presents either several cross-section spectra or a two dimensional map. Two markers allow one to select any couple of spots. Corresponding addresses and contents appear on a front panel digital indicator. They can be fed into the computer. On the other hand, whenever it is worth while, man-machine communication will be accomplished through a set of push-button programs. (auth)

36926 GENERAL SURVEY: ON-LINE DATA REDUCTION AND FEEDBACK IN LOW ENERGY NUCLEAR PHYSICS EXPERIMENTS. Broude, C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 197-204 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The capability of an on-line computer for data reduction and feedback is briefly outlined. The immediate access to an on-line computer permits two broad classes of data reduction: digital operations which can be performed on data event-by-event as it arrives from the detecting equipment; and the ability to operate on mass of data that can exist at any time during the experiment so that a full evaluation of the state of the experiment is possible. Two examples of real-time feedback control, which are virtually independent of the experiment itself, are given. An example of on-line sorting and manipulation of data is also given. (L.B.S.)

36927 ON-LINE DATA ACQUISITION WITH FEEDBACK TO ACCELERATOR CONTROL—A STATUS REPORT. Miller, W.; Meadows, J.; Smith, A.; Whalen, J. (Argonne National Lab., Ill.). pp 222-32 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The principles underlying the utilization of an on-line computer system for data acquisition, processing, and analysis and for accelerator control in a nuclear data laboratory are delineated. The system components and their correlation including nucleonic apparatus, the digital computer, and the nuclear accelerator (pulsed Van de Graaff) are described. Particular attention is given to the relation of the digital system to the analog operation of the accelerator. Experience with the data acquisition and processing portions of the system, and, to a lesser extent, with the accelerator control is described. Specific examples dealing with fast neutron time-of-flight, and total neutron cross sections using pulsed and steady beams are given. Final remarks deal with the simultaneous utilization of the digital system from two geographically isolated accelerator laboratories and with the digitalization of the basic accelerator operation. (auth)

36928 BUBBLE CHAMBER DATA ANALYSIS USING A SCANNING AND MEASURING PROJECTOR (SMP) ON-LINE TO A DIGITAL COMPUTER. Snyder, J. N. (Univ. of Illinois, Urbana); Hulsizer, R. J.; Munson, J. H.; Schneider, H. pp 239-48 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The Scanning and Measuring Projector (SMP) is a semi-automatic instrument for making rapid and accurate measurements on bubble chamber photographs. The SMP, its human operator, and a general purpose digital computer work together in an integrated system in which the computer program determines and controls the sequence of events which constitute the scanning and measuring processes. The operator scans the film, recognizes events, and guides the measuring head of the device along the approximate path of the points to be measured. A brief description of the novel digitizing mechanism is given. The logical structure of the control program is described. Also discussed are the computer specifications desirable in such a system, the possibility of time sharing the computer with a background service load, multiple SMP system, and the computational load imposed on the computer by the system. Data on measuring rates, failure rates, and accuracy gained through actually operating such a system for over one year are presented. (auth)

36929 OPERATION OF AN INSTRUMENT FOR THE SEARCH FOR UNSTABLE PARTICLES USING SONIC SPARK CHAMBERS AND CONVENTIONAL ELECTRONICS WITH AN ON-LINE COMPUTER AND MAGNETIC TAPE. Blieden, H.; Freytag, D.; Iselin, F.; Lefebvres, F.; Levrat, B.; Maglic, B.; Slettenhaar, H. (CERN, Geneva). pp 249-56 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

An experiment is proposed for studying the possible production of heavy mesons in the two-body reaction $\pi^- + p \rightarrow p + x^-$, using an instrument in which the mesons x^- will be detected indirectly in the missing mass spectrum of the protons. The experimental methods, the type of data that will be accumulated, and recording of the information are discussed. The on-line operation of an IBM 7330 computer and magnetic tape with sonic spark chambers and conventional equipment is described for the data analysis and as a control instrument for the different parts of the experimental apparatus. (L.B.S.)

36930 GENERAL SURVEY: STORAGE SYSTEMS—PRESENT STATUS AND ANTICIPATED DEVELOPMENT. Louis, H. P.; Shevel, W. L. Jr. (International Business Machines Corp., Yorktown Heights, N. Y. pp 323-37 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

Innovations in memory system capability and functions, in technology, and in concepts, which have come about since previous surveys, are pointed out. A review of commercially available memories is made, and the increasing number of types of memories and memory functions and its implication on the design of more sophisticated systems are discussed. The impact of new technologies of future progress is treated for various types of memory. Fundamental limitations are identified and new concepts of memory organization intended to overcome these limitations are outlined. (L.B.S.)

36931 A BUFFER STORE DESIGN FOR SONIC SPARK CHAMBER DATA RECORDING. Wells, F. H. (United Kingdom Atomic Energy Research Establishment, Harwell, Berks, Eng.). pp 374-8 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The timing data from a sonic spark chamber were used to accurately define the point of traverse of a high energy particle through the chamber. This timing may be measured in a digital form by gating a timing crystal oscillator, typically 4 Mc/s, and counting the pulses from the gate with a scaler. A complex experiment may require as many as 128 such timing-scaler systems combined with a very fast read-out method to a digital computer. This buffer store design replaces such an assembly of scalers by one timing-scaler combined with a fast ferrite core, word organized store of 128 words at 16 bits per word. The logic design of this store differs very considerably from conventional computer memories since two or more words may have to be written simultaneously during any clock period which in the present design is 0.25 microseconds. The design and performance of this store using the fastest available ferrite ring elements is described together with the read-out on-line connections to a digital computer and magnetic tape system. (auth)

36932 A DISPLAY SYSTEM FOR USE WITH AN ON-LINE COMPUTER. Dimmler, G.; Krueger, G. (Kernforschungszentrum, Karlsruhe, Ger.). pp 393-8 of Automatic Acquisition and Reduction of Nuclear Data.

Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A flexible automatic display system for use with the Karlsruhe multiple input data acquisition system is described. The system provides the display of multiparameter spectra in two and three dimensional representation (e.g., brightness map or isometric picture). It involves two cathode-ray tubes, one for a general view, and the other for detailed examinations. The system can be operated in the computer-controlled mode. However, since in the on-line computing facility a small computer (CDC 160-A) is heavily loaded by simultaneous data acquisition from many experiments, storage capacity and computer time are very restricted, thus excluding a computer-controlled live display in most cases. Therefore, another mode of display operation has been set up in which the computer sends the previously selected part of the stored information to an external system which generates the display picture. Using digital switches the experimenter can choose a wide variety of different display patterns and can correlate the display pictures on the two scopes. (auth)

36933 A COMPUTER CONTROLLED DISPLAY SYSTEM FOR NUCLEAR EXPERIMENTS. Whalen, J. F. (Argonne National Lab., Ill.). pp 399-408 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The basic characteristics and requirements for a nuclear display system are discussed covering the topics of versatility, storage requirements, and the proper balance between fixed wired controls and computer programmed controls. An existing computer controlled display system is described showing modes of display and calibration techniques. A new display system being designed is also discussed. This system incorporates a small buffer magnetic drum memory for display data storage which can be used as an auxiliary memory for the computer since it has random access for both the read and write modes. A method of identifying for the computer particular data points or areas of interest is also available. (auth)

36934 THE RAPID TRANSMISSION OF ENCODED INFORMATION OVER NORMAL TELEPHONE LINES. McNaught, R.; Pearson, A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 409-12 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

It was found that the rapid transmission of encoded information from an experiment to a digital computer is feasible over normal telephone lines. In one system encoded events stored on a magnetic tape are transmitted at a rate of 5000 words per second over a distance of about one-half mile and sorted into a computer store. Thirteen pairs of wires are used to accommodate the complete word. A pulse applied to one end of the line has a rise-time constant of about 6 μs when it appears at the receiving end. One advantage of the direct connection of a remote tape system to a sorter is the elimination of compatibility requirements between write and read stations. In another application a shorter (700 feet) telephone link is used and pulses as short as one microsecond can be transmitted. (auth)

36935 DATA HANDLING INSTALLATION FOR THE LINEAR ACCELERATOR FOR THE C.B.N.M. Horstmann, H. (Euratom-Central Bureau for Nuclear Measurements, Geel, Belg.). pp 413-17 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A general survey is made of the data handling system for the C.B.N.M. 60 Mev electron linear accelerator, which will be used exclusively for neutron production. Neutron time-of-flight data are transmitted to computers at Brussels and at Ispra, Italy for processing and analysis by a tele-processing system via telephone lines at a rate of 160 to 300 characters 1/sec. The operation of the tele-processing system is explained, especially the method of detecting transmission errors. A brief review of the data transmission and analysis concepts is given. (L.B.S.)

36936 A DISPLAY SYSTEM AND ANALOGUE COMPUTER FOR SONIC SPARK CHAMBERS. Maskell, S. C.; Smith, P. E.; Wilde, P. (Rutherford High Energy Lab., Chilton, Eng.). pp 426-36 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The increasing complexity of high energy physics experiments made possible by the use of digital data recording methods has presented problems in obtaining rapid appreciation of the progress of the experiments. For two experiments recently carried out at the Rutherford Laboratory using sampling spark chambers with sonic detectors, equipment has been developed so that the position of the sparks in twelve chambers, with two dimensions in each chamber, can be displayed as spots on a storage oscilloscope. This considerably simplifies the lining up and testing of apparatus. This work resulted in the development of certain elements which, later considerations showed, could be used as simple analog computing units. A special purpose computer, using these elements, was constructed to control the data recording in an experiment. This achieved a reduction in effective background to ten times enabling the experiment to be run with slow data recording and off-line computing. Though similar results could be obtained by fast data readout and on-line computing, the low cost and increased flexibility of this local computer demonstrates that analog computing can still play a significant role in high energy physics experiments. This is particularly true in the control rather than in the final data analysis of the experiment. (auth)

36937 GENERAL SURVEY: CURRENT IDEAS IN THE CONTROL OF COMPUTING SYSTEMS. Sayre, D. (International Business Machines Corp., Yorktown Heights, N. Y.). pp 465-74 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

Some of the principles of control programming are discussed, and the classes of events which set the control system in operation are given. Using the IBM system 1360 as an example, the following system responses are discussed: initiation and control activity, operating input-output devices; change of storage-protection pattern; and return of processor to ordinary processing. The problem of work scheduling and allocating the machine facilities are discussed. The handling of storage by a multiprogramming control program is treated. (L.B.S.)

36938 THE PHYLIS EXECUTIVE PROGRAM. Miller, W. F.; Fisherkeller, M. A.; Hillstrom, K. (Argonne National Lab., Ill.). pp 475-82 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The PHYLIS (PHYsics on-Line Information Station) data analysis system utilizes an ASI 2100 computer as the controlling and monitoring device. The PHYLIS Executive Program is a program which resides in the ASI 2100 computer and whose function is to accept instructions from the experimental physicist conducting an experiment and to execute the appropriate control functions for the system. The executive program permits two categories of operation: the execution of data processing codes in the ASI 2100 on data received from either the Nuclear Data Multi-Channel Analyzer or a remote station, and the execution of data processing codes in the CDC 3600 on a real time interrupt basis. The structure and key operating features of the control program in the ASI 2100, the principal features of the real-time monitor in the CDC 3600, and the working experience with these programs are discussed. (auth)

36939 DATA-HANDLING PROGRAMS IN USE WITH THE PHYLIS COMPUTING SYSTEM. Gemmell, D. S. (Argonne National Lab., Ill.). pp 483-93 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

Data-handling programs currently in use with the PHYLIS system fall into two categories: programs which perform routine operations involved in the actual collection of experimental data, and analysis programs for use on-line. In

the first category, a generalized program has been written incorporating about sixty different data-handling functions. Many of these functions simply perform data transfers (e.g., pulse-height-analyzer to computer, computer to magnetic tape, etc.). There are also several functions associated with the collection of two-parameter data (e.g., the digitized pulses corresponding to each event analyzed may be stored on a magnetic tape unit. These pulses may then be sorted on-line into a matrix of dimensions up to 1024 × 1024 using the large computer CDC 3600 to which the PHYLIS central processor is satellited). In addition, the generalized program contains some elementary data-reduction functions (e.g., integrating counts under peaks, taking slices through matrices, etc.). The experimenter controls the system via a typewriter and three interrupt buttons. He may readily select any function or sequence of functions to be executed when the appropriate button is pushed. Analysis programs can be run on-line using either the PHYLIS central processor or the larger CDC 3600. Several such programs are in current use, e.g., polarization calculations for neutron scattering experiments, least squares fitting, reaction kinetics, γ-ray spectrum unpeeling, etc. (auth)

36940 A SURVEY OF PROGRAMS FOR THE CHALK RIVER PDP-1 COMPUTER. Ferguson, A. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 494-9 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The principal use of the PDP-1 computer has been the accumulation and processing of spectra obtained in tandem accelerator experiments. For this purpose a program has been written that can transfer spectra from pulse height analysers to the computer memory, display on the scope, mark regions of spectra and sum the counts in marked areas, add or subtract two spectra with a renormalization factor, type out spectra or punch them on paper tape and other functions concerned with identification, energy calibration, etc. Programs for special multiparameter analysis of data entered on-line through ADC's can be associated with this program. The sequence break facility enables display and analysis of such data as it is being accumulated. A number of programs have been written for off-line data analysis. These comprise a general least-squares fitting program, capable of both linear and non-linear analysis and a program for the fitting of data by Legendre polynomials. A program for the analysis of spectra by least squares has been started, the part required for the reproduction of standard line shapes by interpolation between measured lines being complete. An extensive program for ion optic calculations has been written to facilitate studies of the beam system of the new tandem accelerator to be installed. This program contains a minimizing routine based on Davidon's method which is used to obtain focus conditions and other optima. All of these programs use the single-precision floating-point system supplied with the computer. Routines for double-precision fixed-point operation have been written at Chalk River, and these have been used to implement programs for reaction kinematics and the calculation of calibration tables for the accelerator. (auth)

36941 RECENT DEVELOPMENTS IN COMPILER AND ASSEMBLER USAGE IN ON-LINE NUCLEAR PHYSICS RADIATION ANALYZERS. Kane, J. V. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 500-6 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

The Brookhaven-Bell Nuclear Radiation Analyzer-Stored Program Computer system has been operating at the 60-inch Brookhaven National Laboratory Cyclotron for about one year. During this time, no hardware changes other than maintenance procedures have been implemented. On the other hand, the software techniques were radically revised. It was found that the FORTRAN language is more suitable to data acquisition procedures than was anticipated when the system was designed and accordingly FORTRAN statements are coded about five to ten times as frequently as Assembler language statements. This corresponds an improvement of 50 to 100 times in the rate of production of machine code. Results and techniques employed are shown and possibilities for further improvement in such systems via ALGOL, Syntactical Assemblers and Improved Compiler systems (such as Real Time FORTRAN) are discussed. (auth)

36942 MULTI-PROGRAMMING AN ON-LINE CONTROL COMPUTER. Vakil, N. P.; Youston, D. J. (DCF Systems Ltd., Malton, Ont., Can.). pp 507-11 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

Digital computers are being increasingly accepted for on-line process control. The requirements for such applications have been reflected in the design of suitable computers and also in the evolution of programming techniques which take advantage of the developments in hardware. One of these, multi-programming, enables several programs to be run concurrently. Aspects of multi-programming an on-line computer in an experimental reactor control installation at Chalk River Nuclear Laboratories are discussed. The computer has to perform several functions such as the examination of alarm conditions, control of reactor power, the storage of reactor data and their display on a cathode ray tube. There are thus a number of programs which have to be co-ordinated by an executive program. The discussion is limited to details of the executive program, the method of storage of real-time reactor data and their presentation on the display. (auth)

36943 GAP—A GENERAL, CONCISE LANGUAGE FOR CRITERION FULFILLMENT PROBLEMS. Bergstroem, A. (Research Inst. of National Defense, Stockholm). pp 512-16 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

GAP is a language designed for problems for which the solution is obtained by scanning a prescribed domain in a parameter space to find the point or points where some specified criterion is fulfilled. Applications to this method of solution are for instance least squares or maximum likelihood estimation of parameters in a theoretical distribution from experimental data, in which case the criteria are minimum of the sum of squares of the deviations and maximum of the likelihood function respectively; another application is the solution of linear or transcendental equations or systems of such equations in which case the criterion is equality between the membra. The GAP language is sufficiently flexible to describe a great variety of problems of this kind and should provide a swift and safe way of solving criterion fulfillment problems except for very complex functions or hard-to-express criteria. A GAP processor exists for IBM 7090. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstracts 38081, 38173, and 38181.

36944 (AD-602952) CRACK INITIATION IN CRYSTALLINE MATERIALS. Interim Technical Report No. 1. Packman, P.; Schroder, K.; Weiss, V. (Syracuse Univ. Research Inst., N. Y. Dept. of Chemical Engineering and Metallurgy). July 1964. 116p. (SURI-MET-1160-0764 IT). CFSTI, $4.00 cy.

The influence of several macroscopic and microscopic parameters of the fracture of crystalline materials was studied on commercially pure W, Ti-2.5 Al-16U alloy, and LiF single crystal specimens. Test results showed that the continuum mechanical maximum stress theory predicted the correct behavior of these materials when surface preparation techniques were identical. Microplasticity at the surface seems to influence the mode and stress for crack initiation and fracture. Bend test results on LiF showed that small cleavage cracks at the surface were not necessarily responsible for crack initiation. The actual dislocation process occurring at or near the surface was strongly dependent on the condition of the surface. Based on the equations of Neuber, the position of the maximum stress for an elliptical crack inclined at an arbitrary angle to the applied load was calculated. The results showed that the crack should grow independent of the angle of the elliptical hole and approximately normal to the applied load. This indicates that crack initiation may occur by dislocation mechanisms other than those proposed in the literature. Models were proposed to explain the network of dislocations present at the tip of 100 and 110 cleavage cracks. (auth)

36945 (AD-610867) THE EVALUATION OF HIGH-TEMPERATURE MATERIALS. SECTION I: EVALUATION OF COATINGS FOR REFRACTORY ALLOYS. SECTION II. MATERIALS EVALUATION WITH AN ARC-PLASMA-JET. Wurst, J. C.; Cherry, J. A. (Dayton Univ., Ohio. Research Inst.). Sept. 1964. Contract AF33(616)-7838. 170p. (ML-TDR-64-62(Vol.II)). CFSTI, $5.00 cy, $1.00 mn.

Section I describes the evaluation of oxidation-resistant coatings for TZM molybdenum (Mo−0.5Ti−0.07Zr−0.03C) and B66 niobium (Nb−5V−5Mo−1Zr). Eight coatings for TZM were evaluated with primary emphasis upon four of these. Six coatings for B66 were evaluated with the bulk of this effort concentrated upon two coating systems. Test results covering complete metallographic analysis, tensile and bend tests, cyclic oxidation tests in the temperature range of 1600 to 3000°F, and the results of creep-rupture tests complete with a statistical analysis are presented. Section II describes the screening tests of 32 different high-temperature materials, including ablative materials, impregnated porous ceramics, and refractory composites, in an arc-plasma testing facility. Included are screening data for several refractory materials developed from tests of 1-inch diameter discs. This disc test is described in detail and its relative merits as compared to more conventional flat panel tests are discussed. Materials performance data are presented as a tabulation of test conditions and their effects upon specimen behavior. (CFSTI)

36946 (AEEW-R-424) THE VAPOUR PHASE DEPOSITION OF BORON ON TITANIUM BY THE REACTION BETWEEN GASEOUS BORON TRICHLORIDE AND TITANIUM METAL. Final Report. Cameron, D. J.; Shelton, R. A. J. (Manchester Univ. (England). Dept. of Metallurgy). Mar. 1965. Contract A/WIN/EMR/92. 55p. Dep.; BIS, $1.80; HMSO, 9s.

The reaction between boron trichloride vapor and titanium was investigated in the temperature range 200−1350°C. It was found that an initial reaction leads to the formation of titanium tetrachloride and the deposition of boron on titanium, but that except for reactions between 900 and 1000°C, the system is complicated by the formation of lower titanium chlorides due to secondary reactions between the titanium and titanium tetrachloride. (auth)

36947 (APEX-681) IRON−CHROMIUM−ALUMINUM-YTTRIUM ALLOYS FOR CLADDING APPLICATIONS TO 2400 deg F. Collins, J. F.; McConnaughey, N. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). June 12, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 28p. Dep.(mn); $2.00(cy); 1(mn) CFSTI.

The Fe−25 Cr−4 Al−1 Y alloy was developed as a high temperature cladding material having superior oxidation resistance for long time service at temperatures to at least 2500°F. A summary is presented of the research data that determined the optimum composition, the procedures for melting, casting, and working the alloy to useful shapes, the mechanical properties, and the oxidation resistance of the optimum alloys at temperatures up to 2500°F. It is shown that the material used as a 0.010-inch-thick cladding in unstressed conditions may be expected to resist oxide penetration for well over 2000 hours at 2300°F, 1000 hours at 2400°F, 500 hours at 2450°F, and 300 hours at 2500°F. The mechanical strength of the Fe−Cr−Al−Y alloy is relatively low above 1500°F and the material has little value as a structural material at elevated temperatures or under stressed conditions. As a fuel element cladding material, the alloy is unexcelled to temperatures of 2400°F. (auth)

36948 (BDX-613-66) ELECTRODEPOSITION OF NICKEL–COBALT ALLOY: OPERATING PARAMETERS AND PHYSICAL PROPERTIES OF THE DEPOSITS. A Preliminary Report. Endicott, D. W.; Knapp, J. R. Jr. (Bendix Corp., Kansas City, Mo.). Aug. 26, 1964. Contract AT(29-1)-613. 78p. (CONF-650702-1). Dep. mn; CFSTI, $3.00 cy, $0.75 mn.

From American Electroplater's Convention, New York.

Nickel−cobalt alloys deposited from a sulfamate bath are described with respect to solution operating parameters and the physical properties of the deposits obtained. The effects of the solution metal ratios, anode characteristics, bath temperature, boric acid contents, and applied current densities on the deposit compositions obtained are discussed. Physical properties (tensile strength, yield strength, elongation, hardness, and grain structures) of the alloy deposits are correlated with composition and heat treatments up to 1150°F. Also, the properties of pure nickel and pure cobalt deposits produced from the basic sulfamate solution along with nickel deposits produced from solutions containing selected additives are discussed. Testing procedures, equipment, and analytical techniques utilized for bath control and deposit testing are described. (auth)

36949 (BNL-900(p.121-97)) METALLURGY DIVISION. Gurinsky, D. H. (Brookhaven National Lab., Upton, N. Y.).

A Zr and Mg pretreated natural circulation, Inconel-clad carbon steel Hg-loop ran for 4568 hr at 593°C in the boiler and 700°C in the superheater. Maximum corrosion was >1000 μ in a superheater weld. A Ta loop is still operating successfully after 16,460 hr at 648°C in the boiler and 740°C in the superheater. The second (annealed) Nb−1 Zr loop is still running after 4724 hr at 760°C in the boiler and 870°C in the superheater. Liquidus curves of Co and Ni with Hg are reported. Initial studies of corrosion by Na−15% Li are described. Electromobilities of Cr in liquid Bi were measured. Neither Ta nor W dissolves in liquid Bi. Nb is sensitive to embrittlement by liquid Bi, as predicted. Surface superconductivity layers that persist above the usual bulk critical fields were identified on dilute alloys of Bi in Pb. The kinetics of gross dislocation movements in Fe are being studied. The effect of radiation is the prevention of

dislocation tangling during straining, since more dislocations are present in the irradiated samples. Studies of the low-temperature stress plateau in Fe showed that the onset of twinning exerts no influence on the continuity of the yield-stress curve. Irradiation of specimens of 6061 T-6 Al showed that radiation-induced overaging of this material will not be a problem in the HFBR. Examination of UC spheres irradiated in Na in the BGRR for 1500 hr at 650°C showed that no sintering of the spheres occurred. There was a surface reaction, however. Both the rate and activation energy for oxidation of graphite are the same for unirradiated and alternately irradiated and annealed samples. Radiation effects on the thermal resistivity of graphite are primarily due to interstitials. The clusters of defects produced during 350°C anneals of irradiated graphite are less stable to irradiation than the interstitials formed during former irradiations. The thermodynamic properties of ThC_2, ThC, and substoichiometric ThC were determined by using a solid electrochemical cell. Diffusion coefficients of Xe in substoichiometric ZrC increase with decreasing C content. Techniques for preparation of irradiation samples of U-Zr carbides were developed. Addition of ≈10 vol % Mo reduces the fracturability of these specimens. Studies of the U-Zr-C system are continuing. The failure in the boiling K heat transfer loop probably was caused by a short circuit between the pipe and the heater. The development of superconducting tunneling junctions is described. (J.R.D.)

36950 (BNL-928) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 3, Number 2, April 1965. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. 53p. Dep.(mn), $3.00(cy); 1(mn) CFSTI

A total of 23 reviews are presented of current topical and progress reports on various research and development programs in U.S. on high-temperature liquid-metal technology. Among the phases covered are corrosion, heat transfer, fluid dynamics, component development, properties, etc. Subject and organization indexes are included. (D.L.C.)

36951 (GEMP-47A) HIGH-TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT NO. 47. PART A. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). May 28, 1965. Contract AT(40-1)-2847. 108p. Dep.(mn); $4.00(cy), 2(mn) CFSTI

Progress is reported in sections on oxidation-resistant fuel element materials, high temperature reactor materials, effects of radiation on high temperature metals and alloys, and high-temperature thermocouples and electric materials. Separate abstracts were prepared for each section. (W.L.G.)

For abstracts of individual sections see: 36952, 37030, 37031, and 37165.

36952 (GEMP-47A, pp 13-26) OXIDATION-RESISTANT FUEL ELEMENT MATERIALS RESEARCH. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation)

Laboratory testing of Fe-Cr-Al-Y-clad fueled specimens has exceeded 6700 hours at 1100°C and 950°C in air with continuing indication of excellent stability. The presence of uranium at low concentration was detected by electron microprobe analysis in the 2541 alloy cladding of an Fe-Cr-UO_2 specimen after 5000 hours at 1100°C. No uranium diffusion was detected for a 2541-clad Fe-UO_2 core tested under the same conditions. Apparently, irradiation of aged 1541 alloy causes partial solutioning of the precipitate as indicated by post-irradiation aging at 425°C. Oxidation resistance of the irradiated alloy at 900°C was the same as for unirradiated material after 200 hours. Corrosion testing of various compositions of Fe-Cr-Al-Y alloys has continued in both air and superheated steam at temperatures of 450 to 1100°C for times up to 7000 hours. The Fe-Cr-Al-Y alloys continue to exhibit lower weight gains in steam at 730°C than nickel-base alloys or ferritic stainless steels. (auth)

36953 (HW-84609(p.5.1-5)) FUEL STUDIES. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Results of ceramic fuel studies are summarized. Included are data and information on PuO_2-NiCr compatibility. PUN preparation, PUN-ZrN phase studies, and preparation of UO_2-PuO_2 fuel. Radiation effects testing on ceramic fuels is reported along with PRTR fuel element performance and fabrication. Data are included from irradiation testing of Th-U fuel elements. (J.R.D.)

36954 (IS-1184) A UNIVERSAL ELECTROPOLISHING METHOD. Hopkins, E. N.; Peterson, D. T.; Baker, H. H. (Ames Lab., Iowa State Univ. of Science and Tech.). June 21, 1965. Contract W-7405-eng-42. 30p. (CONF-650414-3). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From 19th Metallographic Group Meeting, Oak Ridge, Tenn.

An electrolytic polishing method utilizing a low temperature perchloric acid-methanol electrolyte has been developed. Over fifty metals have been successfully polished with this method. Examples of voltage current-density curves are given and photomicrography of both optical and transmission electron microscopes examples are shown. (auth)

36955 (N64-20815) STUDY OF IMPROVED BERYLLIUM OXIDE MATERIALS FOR MICRO-ELECTRONICS TECHNOLOGY. Bimonthly Report, July 1-August 31, 1963. Hessinger, Philip S. (National Beryllia Corp., Haskell, N. J.). Sept. 15, 1963. Contract NASw-685. 20p. (NASA-CR-56190). CFSTI, $1.60 cy.

Study of the growth of single crystals of beryllium oxide was pursued in two ways: growth of BeO crystals by the water-vapor transport technique, which utilizes the generation of $Be(OH)_2$ vapor from a BeO nutrient with a subsequent condensation on a seed surface at elevated temperatures; and an exploratory study of the flux growth method utilizing alkali molybdate solvents. Studies were also conducted to determine the precise dielectric, optical, and thermal properties of beryllium oxide single crystals. (CFSTI)

36956 (NBS-TN-251) RESEARCH ON CRYSTAL GROWTH AND CHARACTERIZATION AT THE NATIONAL BUREAU OF STANDARDS, JANUARY TO JUNE 1964. McMurdie, Howard F. (ed.) (National Bureau of Standards, Washington, D. C.). Oct. 19, 1964. 77p. GPO, $0.45.

A wide program of studies involving crystalline materials is being conducted. These include investigation of methods and theory of growth, study of detection and effects of defects, determination of physical properties, refinement of chemical analysis, and determination of stability relations and atomic structure. The types of materials range from organic compounds, through metals, and inorganic salts to refractory oxides. Progress of these various projects is summarized. (auth)

36957 (NP-15113) STUDY OF DUCTILE COATINGS FOR THE OXIDATION PROTECTION OF COLUMBIUM AND MOLYBDENUM ALLOYS. Bimonthly Progress Report No. 1, March 1-April 30, 1965. Clarke, J. F.; Girard, E. H. (Metals and Controls Inc., Attleboro, Mass.). May 30, 1965. Contract NOw 65-0340-f. 21p.

Platinum is being investigated as a ductile, oxidation-resistant coating for protection of niobium and molybdenum alloys at temperatures to 3000°F. While its oxidation resistance has been found to be excellent, its value as a protective coating for the given substrate alloys rapidly deteriorates as a result of platinum-substrate alloy interdiffusion. A research program is being conducted to develop a barrier to this degrading interdiffusion. Twelve materials were selected for initial evaluation potential diffusion barriers. Roll bonding, hot press bonding, electron beam evaporation, and chemical vapor deposition techniques are being used for fabrication of composite coating-barrier-substrate test samples. Screening tests will be conducted in flowing air at 2550°F to determine the relative merits of the various coating-substrate combinations. (auth)

36958 (NP-15139) MACROLAMINATE PARTICLE COMPOSITE MATERIAL DEVELOPMENT. Interim Report No. 6, February 1–April 1, 1965. Simpson, F. H.; Stejskal, L. M. (Boeing Co., Seattle, Wash. Aero-Space Div.). Contract NOw-64-0194-f. 16p.

Specimens made from cubical shaped particles had better oxidation resistance and higher compressive strength than those made using plate-like particles. Specimens made using rectangular shaped particles with one axis elongated have nearly comparable oxidation and compressive properties to those made from cubical particles and have higher flexural strength. Flexural strength, compressive deformation and weight loss due to oxidation increase with increasing metal content in the composite. The rate of weight loss due to oxidation increases with increasing metal content. Results from hot pressing, isostatic pressing and warm pressing experiments are summarized. Substantial improvements in sintering of the composite have not been realized either by increasing pressure in the vacuum furnace or through use of wet hydrogen. Yielding in flexural specimens prior to ultimate failure was obtained in specimens sintered in wet hydrogen and not in those sintered in vacuum. (auth)

36959 (ORNL-3807, pp 3-79) FUELED-GRAPHITE DEVELOPMENT. Harms, W. O.; Sisman, O.; McCurdy, H. C. (Oak Ridge National Lab., Tenn.).

The effects of coating conditions on the properties of pyrolytic-carbon coatings deposited in fluidized beds were studied. In a series of coating experiments at 1300 to 2000°C, the flow rate of CH_4 relative to the initial surface area of the charge was varied while maintaining a constant total gas flow. Contour plots of the densities and crystallite sizes of all these coatings showed that crystallite size increased systematically from approximately 35 to approximately 140 Å with increasing temperature and decreasing flow rate and that the density of coatings behaved likewise above 1600°C, increasing systematically from approximately 1.5 to 2.1 g/cm^3. A study of the effects of deposition conditions at 1400 to 2400°C on the properties of pyrolytic carbon deposited from CH_4 onto static substrates was completed. Deposits up to 1 mm thick formed at rates ranging from 3.2 to 2810 μ/hr. The average density of the columnar deposits increased with deposition temperatures from 1.23 g/cm^3 at 1400°C to 2.09 g/cm^3 at 2400°C. Anisotropy factors determined by x-ray diffraction increased from 2.0 to 14.6 at 1600 to 2400°C, while anisotropy factors determined from the diamagnetic susceptibility of the deposits showed a similar trend but were lower by 4 to 10%. The effects of heat treatment on spheroidal fuel particles of ThO_2 or UO_2 that had been coated with pyrolytic carbon at 900 to 1400°C were studied. The specimens were heat treated successively to higher and higher temperatures to investigate their thermal stability. Particles with coating thicknesses of at least 85 μ survived heat treatment up to 2700°C without significant reaction. All particles having coatings at least 65 μ thick were unchanged by heat treatment at 1800°C, while thinner coatings sometimes ruptured and reacted with the fuel. Examination by microradiography of particles heat treated at 2000°C or higher revealed gaps between fuel particle and coating that were greatest for particles having low-density anisotropic coatings. A method was developed for converting dense sol-gel oxide microspheres to dense carbide microspheres by heating mixtures of oxide particles with C in a rotating graphite crucible while purging with Ar. Using a fixed carbon-to-thoria weight ratio of 1, complete conversion without agglomeration or reaction bonding to the crucible could be achieved in 5 hr at 2150°C. The temperature coefficient of expansion of ThC_2 and of a series of specimens of $(U,Th)C_2$ ranging in composition from 25.4 to 87.7 mole % ThC_2 were measured. The results expressed as average coefficients over this temperature range, increased steadily from 8.42×10^{-6}/°C for ThC_2 to 13.23×10^{-6}/°C for a specimen containing 25.4 mole % ThC_2. Analysis of ThC_2 x-ray diffraction patterns yielded the following lattice parameters: a = 8.296 A, b = 4.232 A, c = 10.538 A, and β = 90.23°. The thermal conductivities of fueled-graphite bodies were found to be significant functions of temperature and indicate that the conductivity is not affected by thermal-neutron irradiation to exposures of about 10^{19} neutrons/cm^2 at 800°C. Irradiation of capsule 05-8, which contained three 6-cm-dia. fueled spheres, was completed. A plot of fission-gas release versus burnup is included. Irradiation of the last scheduled eight-ball assembly was completed. The operating conditions are summarized for this assembly, which included pyrolytic-carbon-coated B_4C above the fuel. Postirradiation examinations on several fueled-graphite spheres were completed. The dimensional and weight changes noted would be acceptable for reactor usage. No failures of enriched particles were found. Metallographic examinations were completed on four other experimental assemblies. Heavy-metal burnups (based on enriched particles) varied from 1.2 to 17%, and sphere surface temperatures ranged from 1280 to 1850°F (plus correction for fission-power heating). Fission-power densities varied from 15 to 80 w/cm^3. No failed coated fuel particles were observed in the metallographic specimens from any spheres from these experiments. Irradiated coated fuel particles from six different batches were metallographically examined. The observed fraction of fractured coatings correlated reasonably well with data from acid leaching; only two of the six batches of particles had suffered more than about 2% failure. The predominant mode of failure was the propagation of wedge-shaped fractures from the core-coating interface outward through the coating. (J.R.D.)

36960 (ORNL-3807, pp 80-142) INVESTIGATIONS OF FUELED-GRAPHITE SYSTEMS. Sisman, O.; Savage, H. W.; Watson, G. M. (Oak Ridge National Lab., Tenn.).

From steady-state experiments with single-crystal UO_2, a defect-trap model for fission-gas release was evolved. A basic assumption for this model is that defects such as grain boundaries will trap fission gases. A mathematical expression for the defect-trap model was derived and in order to evaluate the parameters in the equation, an experiment to allow slight oscillations of temperature and fission rate is in progress. The time-dependent responses of the fission gas to these oscillations are being used to evaluate the mathematical expression. The fractional fission-gas release and postirradiation examination results for nine experimental assemblies containing pyrolytic-carbon-coated fuel particles irradiated to a burnup of 7 at. % heavy metal at 1400°C were obtained. The coatings were on thorium-uranium carbide or uranium oxide cores. Damage to pyrolytic C coatings occurred because of melting of a thermocouple sheath alloy and because the sweep gas became contaminated. Postirradiation anneals on nine groups of pyrolytic-carbon-coated fuel particles were completed. Samples irradiated up to 26% uranium-metal burnup were heated to temperatures up to 2000°C, usually for periods of 7 hr. Coating failures were generally less than 2%. The release of ^{85}Kr was a few ppm/hr through unbroken coatings. Solid fission-product release, especially Ba and Sr, was much higher; up to 0.6% per hr at 1370°C, up to 3% per hr at 1700°C, and more than 2% per hr at 2000°C. Ce and Cs release rates were significant, and Ru and Zr were also found. The data from fission product transport studies indicate that I deposition is a function of the material of the deposition surface. Investigations of problems related to contamination of metal surfaces by gas-borne fission products were continued. In studies of actinide diffusion in pyrolytic C, the thin-layer and constant-potential techniques were used to investigate the effects of initial actinide concentration and pyrolytic-C structure and the phenomena of segregation of actinides during diffusion. Autoradiography of specimens from the thin-layer experiments provided an explanation for the nonuniform actinide penetration observed previously. A study of the recoil of fission products in pyrolytic C was initiated to determine fission-fragment distributions in pyrolytic-C targets after exposure to fragment beams. Preliminary data were compiled for the compatibility of various batches of pyrolytic-carbon-coated fuel particles with partial pressures of water vapor of approximately 45 and 565 torr at 1000°C for exposure periods of 1 to 4.5 hr. Reaction rates obtained from weight losses

and the incidence of coating failures as determined from acid leaching of U and Th are included. (J.R.D.)

36961 (ORNL-3807, pp 143-4) STUDIES FOR AVR-GERMAN PEBBLE-BED REACTOR. McCurdy, H. C. (Oak Ridge National Lab., Tenn.).

Irradiation of capsule 01A-8 was completed. The three AVR fueled spheres in this capsule contained pyrolytic-carbon-coated UC_2 in a graphite matrix with a 1-cm-thick ATJ machined shell. The significant data and the fission-gas release measurements made during the tests are included. (J.R.D.)

36962 (ORNL-3807, pp 145-76) INVESTIGATIONS OF MODERATOR MATERIALS. Harms, W. O.; McCurdy, H. C.; Watson, G. M.; Witt, F. J. (Oak Ridge National Lab., Tenn.).

Specimens of AGOT and CGB graphite were tested in an in-pile creep experiment in which cooling fins were used to reduce the average specimen temperatures to 155°C. The initial stress levels were 540 to 3210 psi, but the load was increased during the test to give stress levels of 790 to 4710 psi. Substantial negative displacements at the initial stress levels were noted. A creep coefficient of 3.5×10^{-10} (in./in.)/psi (Mwd/at) was determined. The results are consistent with the Cottrell model for irradiation creep and demonstrate that irradiation-induced creep enables graphite to absorb much more strain (> 0.6% in this experiment) without fracturing. Determinations of rates of reaction of a 1-in.-dia sphere of ATJ graphite with low concentrations of H_2O and CO_2 in flowing He (1 atm) at 875°C. The apparent orders of reaction were 0.6 to 0.7 for both the H_2O and CO_2 systems at 875°C with H_2O concentrations of 30 to 780 ppm and CO_2 concentrations of 50 to 980 ppm. The H_2O-graphite reaction was strongly retarded by both H_2 and CO. There was a linear relation between the reciprocal of the reaction rate and either the H_2 or CO concentration. Reaction rates of mixtures of H_2O and CO_2 with ATJ graphite were less than the sum of the individual reaction rates at comparable oxidant concentrations. Continued study of the failure characteristics of EGCR-type AGOT graphite at room temperature is reported. Analytical representations of the stress-strain relations were derived. A computer program based on the elasto-plasticity analysis of a thick-walled graphite cylinder was written. With this code, experimentally determined stress-strain curves can be used directly in computing stresses and strains in thick-walled cylinders without linear approximations. An irradiation experiment for studying the compatibility of BeO and graphite was started to (1) determine the extent to which the reaction $2BeO + 3C \rightarrow Be_2C + 2CO$ between graphite and beryllia in contact at 1500°C proceeds in a high-intensity radiation field, (2) investigate the movement of the ^6Li formed by the nuclear reaction $Be(n,\alpha)^6Li$, and (3) obtain additional information on the irradiation damage of graphite and BeO. (J.R.D.)

36963 (TID-6506(Pt.1)(3rd Ed.)) SUMMARIES OF FUELS AND MATERIALS DEVELOPMENT PROGRAMS. Rice, William L. R. (ed). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Oct. 1964. 264p. Dep. mn; CFSTI, $6.00 cy, $1.25 mn.

This part includes fuels and materials research in the AEC Division of Reactor Development and Technology, other than that supported by various reactor projects. U.S.-Euratom joint contracts are also covered. The contractors are listed alphabetically, and a subject index is included. (D.L.C.)

36964 (AEC-tr-6586) HYDROGEN ABSORPTION BY BERYLLIUM. Blanchard, R.; Bochirol, L. Translated by Anne C. Foell (Phillips Petroleum Co., Idaho Falls, Idaho) from p.157-62 of Colloq. Met., 5e, Centre Etudes Nucl. Saclay, (Gif-sur-Yvette, France), 1961. 10p. Dep. mn; JCL, $1.10 fs, $0.80 mf.

The quantities of hydrogen taken up by beryllium under pressures ranging from 300 to 760 mm Hg and temperatures between 500 and 750°C were measured. Beryllium absorbs little hydrogen (20 to 50 times less than stainless steel under similar conditions). Several factors connected with the metal processing (BeO content, dislocations) greatly influence the absorption capacity. In the conditions of the present study, the H–Be compatibility seems thus satisfactory. But it would not be safe to extrapolate these results to the behavior under irradiation, since ionization of hydrogen and helium formation in the metal may have a disturbing influence on the behavior of Be in the presence of hydrogen. (auth)

36965 (EURAEC-618) RESULTS OF WORK CARRIED OUT FROM JANUARY 1 TO MARCH 31, 1963 [ON Zr ALLOYS]. Quarterly Report No. 4. (Compagnie Pechiney, Paris). Apr. 30, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 067-62-4 RDF. 46p. (A translation). Dep.(mc); $4.60(fs), $1.58(mf) CFSTI.

The extrusion conditions and heat treatments applicable to zirconium alloys are defined to ensure an optimal distribution and fineness for the compounds. The basic binary alloys are: Zirconium alloys with 1.5% vanadium extruded in β phase and annealed for 8 hr at 650°C; zirconium alloys with 3.5% vanadium extruded in the $\alpha\beta$ phase, hardened in the β phase and tempered for 12 hr at 750°C; and zirconium alloys with 0.9% nickel extruded in the β phase and annealed for 8 hr at 650°C. The ternary and quaternary additions of tin and/or titanium. The hardening effect that aluminum has on zirconium is studied. (auth)

36966 LESS COMMON METALS. Sherwood, E. M. Ind. and Eng. Chem., 57: 78-84(Aug. 1965).

The technology and applications of beryllium, chromium, molybdenum, niobium, rhenium, tantalum, tungsten, zirconium, and titanium are reported and evaluated for use as high temperature space-age metals and alloys. (533 references) (F.J.H.)

36967 METHOD OF THICKNESS DETERMINATION OF METALLOGRAPHIC SPECIMENS FOR AUTORADIOGRAPHY. Kominek, Józef; Radwin, Maciej (Inst. of Problems in Technology, Warsaw). Nukleonika, 10: 62-6 (1965). (In Polish)

The thickness of the probe on which metallographic specimens are placed is related to the range of beta rays of the given isotope in the material being investigated. In past autoradiographic investigations, the thickness of the probe was determined by empirical formulas which varied from author to author. Studies were made to determine the maximal permissible thickness of the probe from which the radiation penetrating the extreme layer gives a darkening of the film that is near the darkening produced by a background darkening. Radioisotopes of pure elements were used; Cu, Zn, Tl, Sr, Co, Ni, Mn, As, and P. Five probes were used in each set of exposures. One exposure of the set utilized no absorber between the probe and the film, and the other exposure used five uniformly varying thicknesses of Al absorbers, from zero to maximum thickness. Two tables are given, one for a minimum increment of probe thickness equal to 5.4 mg/cm^2, and one for an increment of 6.75 mg/cm^2. The tables can be applied to any given material by using the approximate relationship, $R_x(Z/A)_x = R_{Al}(Z/A)_{Al}$ where R_x is the thickness of the probe material x that is to be determined, R_{Al} is the thickness of Al which is selected from the table, and Z and A are the atomic number and atomic weight of the corresponding element. (TTT)

36968 NEW PHYSICAL AND CHEMICAL PROPERTIES OF METALS OF VERY HIGH PURITY. Centre National de la Recherche Scientifique International Symposia, Paris, October 12-14, 1959. New York, Gordon and Breach Science Publishers, 1965. 498p. (CONF-591001)

The development of a physical method of metal purification, called zone refining, has made available materials of very high purity. Thirteen papers in three different subject areas are presented; separate abstracts have been prepared for two papers. The subject areas covered include: the analytic methods for identification and measurement of foreign elements and a comparison to physical methods of measurement; the physical and chemical properties of very

high purity metals; and the latest improvements in the zone-refining technique. (W.L.G.)

For abstracts of individual papers see: 36316 and 36969.

36969 NEW IMPROVEMENTS OF THE ZONE-REFINING METHOD. Langeron, J. P. (Metallurgical Chemical Research Center, Vitry, France). p.391-414 of "New Physical and Chemical Properties of Metals of Very High Purity." New York, Gordon and Breach Science Publishers, 1965.

Because of its reactivity with supporting materials, Zr could not be zone refined in the conventional horizontal position. The only possible method, that of the floating zone, was adopted and apparatus constructed. Because of the solubility of O_2 and N_2 in Zr, it was necessary to make the apparatus gastight and use either vacuum or argon atmospheres. An investigation was made of the effects of the rate and direction of motion and power input of the heating source on the properties of the zone refined Zr bar. (W.L.G.)

36970 IMPROVEMENTS IN OR RELATING TO MAGNESIUM BASE WROUGHT ALLOYS. Emley, Edward Frederick (to Magnesium Elektron Ltd.). British Patent 990,969. May 5, 1965. Filed Aug. 11, 1961.

An alloy suitable for use in nuclear reactors at temperatures to 500° C consists of 0.1-1% Zr, 0-0.25% Mn, 0-0.01% Be, and the remainder Mg. Reactor components are fabricated from the alloy by extrusion of compacted particles. Good creep properties of the alloy may be further improved by any of several suggested heat treatments. (A.G.W.)

36971 IMPROVEMENTS IN OR RELATING TO GRANULATION PROCESSES. Garrett, Keith Henry; Adwick, Albert Graham; Batchelor, Eric Richard (to United Kingdom Atomic Energy Authority). British Patent 992,237. May 19, 1965. Filed Mar. 28, 1962.

A process for converting powder into high-density spheroidal granules suitable for use as nuclear fuel consists of forming the powder into agglomerates of paste consistency and rolling the agglomerates on the interior walls of a drum of circular cross section while simultaneously pressing the agglomerates against the walls by centrifugal forces greater than gravity. The drum is swung around a fixed axis parallel to the longitudinal axis of the drum and is provided with a turning motion relative to the fixed axis. The velocity of the drum is controlled to provide a centrifugal force in the range 10-30 times gravity. The process is applicable to metals, metal oxides, metal carbides, and ceramic materials. Preferred binders for forming the agglomerates are alcohols having more than six carbon atoms. (A.G.W.)

36972 METHOD OF PURIFYING REFRACTORY METALS. Brothers, James A. (to Wyandotte Chemicals Corp.). U. S. Patent 3,188,200. June 8, 1965. Filed May 21, 1962.

In a process for removal of oxygen from refractory metals, finely divided particles of Nb, Mo, W, or V are contacted with a mixture of HC1 and hydrogen, argon, or helium at a temperature of 350-1000° C. Preferably the gas mixture includes 10-25% by volume of HC1. (A.G.W.)

36973 FUSED REFRACTORY COMPOSITIONS. Miller, William A.; Sandmeyer, Karl H. (to Harbison-Carborundum Corp.). U. S. Patent 3,188,219. June 8, 1965. Filed Mar. 6, 1962.

Fused cast refractories exhibiting improved resistance to corrosion by molten glass consist principally of Cr_2O_3, Al_2O_3, MgO, and FeO. The combined Cr_2O_3 and Al_2O_3 constitute from about 84 to 90% by weight of the composition, and the percent by weight of the Cr_2O_3 is from 40 to 60% by weight of the Al_2O_3. The oxides are present in such proportions that the product of the mole ratio of Cr_2O_3 to Al_2O_3 and the mole ratio of R_2O_3 oxides to RO oxides is higher than 1.15 and the mole ratio of R_2O_3 oxides to RO oxides is >2.0. The refractories are made from chromite ore with additions of alumina and/or chromic oxide to maintain the proper proportions. (A.G.W.)

36974 METHOD OF MAKING A CONTAINER. Weber, Berthold C. (to U. S. Air Force). U. S. Patent 3,189,473. June 15, 1965. Filed Apr. 2, 1962.

A container for molten Ti may be made by adding methyl alcohol to a mixture of 93.5% ZrO_2 powder and 6.45% Ti powder to form a suspension, casting the suspension into a desired shape, air drying the shape, firing the dried shape in a vacuum at a temperature in the range 1760-1870° C, and cooling the fired shape in the vacuum. The container is chemically inert to Ti and is resistant to thermal shock. (A.G.W.)

36975 OXIDATION-RESISTANT CERAMICS AND METHODS OF MANUFACTURING THE SAME. Shaffer, Peter T. B. (to the Carborundum Co.). U. S. Patent 3,189,477. June 15, 1965. Filed Apr. 13, 1960.

A composite oxidation-resistant refractory article can be made by coating a cellular refractory body with an oxidation-resistant refractory material. The coating consists essentially of a boride of a metal selected from the group of Hf and Zr, a compound of the group consisting of molybdenum silicide, zirconium silicide, tungsten silicide, tantalum silicide, boron nitride, silicon carbide, silicon metal, or a mixture of molybdenum and tantalum silicides, and a binder material such as polyvinyl alcohol. The refractory body is first formed to the desired shape, the coating is applied, and the body is sintered. (A.G.W.)

Corrosion

Refer also to abstract 38132.

36976 (AD-600428) OXIDATION OF CESIUM AT LOW TEMPERATURES AND PRESSURES. Stansbury, E. E.; Epperson, J. E. (Tennessee Univ., Knoxville. Dept. of Chemical and Metallurgical Engineering). May 1964. Contract AF40(600)-1023. 21p. (AEDC-TDR-64-111) CFSTI $1.00 cy.

The research indicated that the oxidation of cesium is very rapid for oxygen pressures approaching 10^{-3} torr at 0°C but is very small at −78°C. At intermediate temperatures, the oxidation curves exhibit the break away phenomenon observed for other alkali metals in which an accelerating rate of oxidation is observed following an initial slow rate. (auth)

36977 (APED-4670) INTERGRANULAR CORROSION OF NONSENSITIZED AUSTENITIC STAINLESS STEELS. II. METALLURGICAL VARIABLES. Armijo, J. S. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1965. 24p.

The intergranular corrosion behavior of nonsensitized austenitic stainless steels in nitric acid-potassium dichromate solutions was studied with respect to the following variables: grain size, cold work, silicon content, carbon content, and heat treatment. The corrosion rate of Type-304 stainless steel increased with increased grain size and decreased with cold work. High temperature annealing treatments decreased its corrosion resistance. Increases in the carbon content of 17Cr−11Ni−0.007% C stainless steel resulted in higher corrosion resistance. Sensitized specimens rich in carbon appear to be more resistant to attack than solid solution alloys of low carbon content. Results of this study are compared with previous work and discussed in terms of solute segregation at austenite grain boundaries. (auth)

36978 (IITRI-B6040-2) DEVELOPMENT OF OXIDATION-RESISTANT HAFNIUM ALLOYS. Bimonthly Report No. 2. Van Thyne, Ray J. (IIT Research Inst., Chicago, Ill.). July 15, 1965. Contract NOw 65-0301-f. 6p.

The effects of various additives on the oxidation resistance of Hf−25 wt % Ta and Hf−12 wt % Nb were studied using static 2500°F air. The most encouraging results were obtained with Cr and Al additions; the appearance of these ternary alloys after oxidation for 10 hr are shown. The optimum Cr or Al content appears to be 10 at.% for

Hf–Ta and 5 at.% for Hf–Nb. The microstructures of the oxidized alloys were studied. (D.L.C.)

36979 (LA-DC-6965) A NEW TECHNIQUE FOR TESTING MOLTEN PLUTONIUM CONTAINER MATERIALS AT HIGH TEMPERATURE. Andelin, R. L.; Hawkins, A. R.; Wilson, N. G. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1965]. Contract W-7405-eng-36. 5p. (CONF-650602-11). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

A method was developed for accelerating the penetration of Pu fuel through the container wall of test capsules. The method is to heat a short fuel capsule inside an evacuated quartz tube assembly, and to detect Pu penetration by means of thermally shielded alpha detectors. When Pu penetration is detected, the experiment is automatically shut down. Preliminary tests with a 97.5 wt % Pu–2.5 wt % Fe–Ga-stabilized fuel alloy in pure Ta capsules show a linear capsule lifetime-temperature relationship. (D.L.C.)

36980 (PWAC–355) CORROSION OF COLUMBIUM BASE AND OTHER STRUCTURAL ALLOYS IN HIGH TEMPERATURE LITHIUM. Freed, M. S.; Kelly, K. J. (ed.) (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). June 30, 1961. Contract AT(11-1)-229. 35p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Comprehensive engineering and laboratory investigations were made to determine the possibility of using lithium metal as a coolant in high temperature systems to 2000F. Iron, nickel and cobalt base materials are limited to temperatures below 1100°F while the refractory metals titanium, zirconium, niobium, tantalum, vanadium, and Mo–0.5 Ti alloy showed no thermal gradient mass transfer effects to 1600°F. On this basis and on the basis of availability and fabricability, niobium was selected for intense investigation in electromagnetic pump engineering loops under inert gas conditions. Unalloyed niobium with oxygen concentration over 0.03 weight percent is extremely vulnerable to lithium attack. This effect can be eliminated by carefully controlling contamination during fabrication, or by alloying with an internal getter such as zirconium. Laboratory anelasticity tests have shown that the zirconium atoms effectively reduce the oxygen atom activity stabilizing the resultant structure. A complete corrosion evaluation of Nb-1 Zr alloy has shown that there is no significant corrosive or solution attack encountered in purified lithium at temperatures up to at least 2200°F, thermal gradients to 400°F, flow rates to 50 feet per second and operating times to 2000 hours when the oxygen content of the alloy is controlled and a post weld heat treatment is performed. Preliminary corrosion data indicate that niobium alloys containing titanium or other metals, which form oxides thermodynamically more stable than niobium oxides, have corrosion characteristics similar to that of Nb-1 Zr alloy. (auth)

36981 OXIDATION OF 80Cb–10Ti–10Mo ALLOY IN THE TEMPERATURE RANGE 500 TO 1200C. Kolski, Thaddeus L. (E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.). Am. Soc. Metals, Trans. Quant., 58: 323-33(1965).

Reaction rates of the 80Nb–10Ti–10Mo alloy with oxygen at 1 atm were determined gravimetrically at temperatures between 500 and 1100°C (930 and 2010°F), for reaction times of 100 hr, and at 1200°C (2190°F) for 25 hr. Temperature dependence of oxidation rate was irregular. Oxidation was very slow at 500°C (930°F) but increased with increasing temperature to an anomalously high rate at 700°C (1290°F). Above 700°C (1290°F) a rate inversion occurred with increasing temperature and the oxidation rate passed through a minimum near 800 to 900°C (1470 to 1650°F). The oxidation rate increased with further temperature increases and became very high at temperatures above 1100°C (2010°F). At 1200°C (2190°F) the oxidation rate of 80Nb–10Ti–10Mo was nearly as high as that of pure niobium. The outer oxide scale formed on 80Nb–10Ti–10Mo at temperatures from 700 to 1200°C (1290 to 2190°F) was similar to the high-temperature form of Nb_2O_5, on the basis of x-ray diffraction patterns. The scale formed at 600°C (1110°F) was not oxidized to the highest possible valence state of all the constituent metals, and produced a diffuse x-ray diffraction pattern. Volatilization of MoO_3 from the scale was significant at 800°C (1470°F) and higher temperatures. The outer oxide formed at 600 to 700°C (1110 to 1290°F) was flaky or powdery, and the superficial region of the underlying metal core was severely cracked. The cracking, which occurred in the heavily oxygen-contaminated zone, was postulated to be the result of steep oxygen concentration gradients produced in the metal by inward diffusion of oxygen, and led to the markedly accelerated oxidation observed at 700°C (1290°F). (auth)

36982 INVESTIGATION OF INHIBITING PROPERTIES OF THE PERTECHNETATE ION. Spitsin, V. I.; Rosenfeld, I. L.; Persiantseva, V. P.; Zamoshnikova, N. N.; Kuzina, A. F. Corrosion, 21: 211-21(July 1965).

Corrosion of iron in an aggressive medium containing sulfate and chloride ions was completely inhibited by addition of minute amounts of the pertechnetate ion. Its effectiveness on the basis of mol concentration required under similar conditions was much greater than that of such widely used inhibitors as the nitrite, chromate, and dichromate ions. The pertechnetate ion was capable of inhibiting corrosion caused by a mol concentration of aggressive ions higher than that of the inhibitor itself. Experimental results indicated that the corrosion inhibiting power of the pertechnetate ion is the result of its adsorption on the metal surface, with resultant stifling of the anodic process of metal ionization. This was accomplished with a quantity of pertechnetate considerably smaller than that needed to produce a monomolecular layer on the metal surface; complete surface coverage was not required for complete inhibition. (auth)

36983 CATHODIC CORROSION OF STAINLESS STEEL IN NITRIC ACID. Epstein, J. A.; Levin, I.; Rabinovitz, E.; Raviv, S. (Israel Atomic Energy Commission. Negev). Corrosion Sci., 5: 461-70(July 1965).

The cathodic corrosion of stainless steel in dilute nitric acid was studied. The rate of dissolution as a function of cell voltage and nitric acid concentration, as well as E to I curves for stainless steel in nitric acid, with and without uranyl nitrate and sodium nitrite, were determined. It was shown that the results may be interpreted in terms of an equilibrium process, involving nitric acid and metal ions in solution and on the surface of the metal. (auth)

36984 EVALUATING CORROSION RESULTING FROM REPEATED CHEMICAL CLEANING. Perrigo, Lyle D. Corrosion Technol., 11: 21-5(Dec. 1964).

The corrosion resistance of coolant systems of pressurized, water cooled nuclear reactors was determined during repeated chemical cleaning with an alkaline (MnO_4) and $NaHSO_4$. The test method, in which the cyclic filming and defilming was simulated, is described in detail as applied to stainless steel, carbon steel, Stellite, and Zircaloy-2 Zr alloy specimens. (Rev. Metal Lit., Vol. 22, (June 1965))

36985 BERYLLIUM CORROSION AND HOW TO PREVENT IT. Stonehouse, A. J.; Beaver, W. W. (Brush Beryllium Co., Cleveland, Ohio). Mater. Protect., 4: 24-8 (Jan. 1965).

Corrosion resistant characteristics of beryllium are reviewed with a discussion of four types of Be corrosion: aqueous, atmospheric, high temperature gas, and liquid metal. Similarly to other light metals, Be readily forms an adherent, protective oxide film on its surface. In low temperature, high purity water, there is little or no corrosion problem with Be. The performance of Be in water can be seriously compromised by the presence of small concentrations of several ions. Chloride ion particularly and also the sulfate ion will cause localized break-down and pits in the Be surface. Thus Be's performance in tap water is poor, and it has low resistance to sea water. Fluoride and chlorate ions as well as sulfate and chloride ions activate and anodically attack Be in solutions of pH 4

to 10.7 where passivation normally occurs. In high temperature water (98.9 to 343.3°C) Be does not have sufficient reliability for service. The resistance of Be to corrosion by the normal atmosphere is good, and it can be stored for years at room temperature without changing in appearance. Behavior of Be in the presence of various gases at high temperature has been studied in connection with the proposed use of the metal in gas-cooled reactor systems, particularly in Great Britain. Oxide films formed on Be are protective in dry oxygen at temperatures to and including 650°C at exposures up to 300 hr. Although the corrosion of Be by liquid metal coolants is primarily of interest to the nuclear reactor field, coolant problems in power generation equipment for space vehicles are considered with a discussion of Be's behavior in such systems. The performance of Be in liquid metal systems is summarized. (TCO)

36986 GENERAL CORROSION OF INCOLOY-800 IN SIMULATED SUPERHEAT REACTOR ENVIRONMENT. Pearl, W. L.; Brush, E. G.; Gaul, G. G.; Wozadlo, G. P. (General Electric Co., San Jose, Calif.). Nucl. Appl., 1: 235-45(June 1965).

Incoloy-800 fuel-cladding material was corrosion-tested under heat-transfer conditions at metal temperatures up to 1410°F (766°C) in specially designed out-of-pile superheat facilities. The hydrogen and oxygen contents of the steam were controlled to simulate those found in boiling-water reactors. The corrosion data from the 4000-hr heat-transfer tests indicated good corrosion resistance up to at least 1300°F (704°C) metal temperature. A compositionally changed layer developed at the metal-oxide interface. The changed layer depth appeared to be a function of time and temperature of exposure. The descaled weight-loss data for the sheaths operated at a metal temperature of 1100 to 1300°F (593 to 704°C) indicated that greater than 80% of the oxide corrosion product adhered during the first 1000-hr exposure, but only about 50% of the total oxidation product remained after 4000 hr. The uniform corrosion experienced by the Incoloy-800 when exposed isothermally to 1050 and 1150°F (566 and 621°C) for 10,000 hr indicated an initially high-corrosion rate that decreases to a lower constant rate within the first 1000 hr. An insignificant amount of the oxide was lost to the system. (auth)

36987 CORROSION-RATE-LAW CONSIDERATIONS IN SUPERHEATED STEAM. Brush, E. G. (General Electric Co., San Jose, Calif.). Nucl. Appl., 1: 246-51 (June 1965).

Fuel cladding materials were corrosion tested under heat-transfer conditions in superheated steam. Each point in the data obtained represented an integrated corrosion response over a temperature gradient along the length of an electrically heated test specimen. An analytical model was developed by which these data may be treated to yield corrosion behavior at a given specific temperature. Corrosion rate laws in superheated steam were examined, and particular emphasis was given to the transition from non-linear to linear rate control. It is argued, in the case of Incoloy-800, that the transition results in true steady-state linear control, thus allowing the model to be used to extrapolate the corrosion behavior of this alloy to long periods of time. (auth)

36988 OXIDATION OF SCANDIUM, YTTRIUM, AND PRASEODYMIUM AT HIGH TEMPERATURES. Voitovich, R. F. (Inst. of Study of Materials, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 31: 550-3(1965). (In Russian)

The oxidation kinetics of 99.9% pure scandium at 600 to 1200°C, of 99.53% pure yttrium at 200 to 650°C, and of 99.7% pure praseodymium at 250 to 700°C were investigated. The metals were oxidized in air for 10 hr and the oxide phases were subjected to x-ray diffraction pattern examination. In the initial, comparatively slow stage of Sc oxidation a dark, protective film, which adhered closely to the metal was formed. At 700 to 900°C, the protective scale consisted mostly of a brown ScN phase. In the second, intense oxidation stage, the ScN phase oxidized rapidly with increasing temperature and at 1000°C was completely transformed to white Sc_2O_3 scale with poor oxidation protection properties. The behavior of Sc in oxidizing atmospheres strongly resembled that of Zr and was completely different from that of Ti and Al. The oxidation yttrium began after a 4-hr exposure at 300°C and followed a parabolic rule. Beginning at 350°C, the oxidation rate was typical for cases where the scale formed gives no oxidation protection. A closely adhering scale was formed at 200 to 400°C, and, at temperatures above 450°C, a powder consisting of Y_2O_3 phase with traces of a YN phase was formed. The oxidation rate of praseodymium was linear, beginning at 250°C. A black scale of Pr_2O_3 composition was formed at 200 to 250°C. At higher temperatures, the specimen turned completely into a black powder at a rate increasing with temperature. No praseodymium nitrate was detected by the x-ray phase analysis. (CFSTI)

36989 METHOD OF INCREASING THE EFFICIENCY OF NUCLEAR REACTORS. (to Elektrophysikalische Anstalt Bernhard Berghaus). British Patent 992,677. May 19, 1965. Priority date Nov. 6, 1961, [Switzerland.]

The operating temperature and thus the thermal efficiency of water-cooled reactors can be increased by increasing the corrosion resistance of metallic structural members. In the process patented, an ionized and/or dissociated gas atmosphere is employed to provide the surfaces of the metallic members with one or several elements increasing the corrosion resistance. A gas atmosphere containing these elements or decomposable compounds of the elements is ionized and/or dissociated by an electrical gas discharge. Preferably the discharge intensity and the selection of material used for treatment are such that approximately equal quantities of material are removed and added. The process is particularly applicable to Zr and Zr alloys; preferred elements for increasing corrosion resistance are Si and C. (A.G.W.)

36990 PROCEDURE FOR THE TREATMENT OF ZIRCONIUM ALLOYS. Anderko, Kurt; Richter, Herbert; Schleicher, Hans-Walter (to Communaute Europeenne de l'Energie Atomique–EURATOM). Canadian Patent 687,009. May 19, 1964. Priority date Mar. 23, 1961, Germany. (In French)

A procedure is given for the treatment of zirconium alloys containing from 0.5 to 5% Nb and up to 3% Sn and 0.5% of each of the following elements: Fe, Ni, Cr, Ta, Pd, Mo, and W. In order to improve the corrosion behavior, the alloys were cold worked at a temperature between 550 and 590°C. The cold working was done after a softening anneal at a temperature above 640°C. There were several cycles of cold working and heat treatment. (J.S.R.)

36991 APPLICATION OF BERYLLIUM ALLOYS. Raine, Thomas; Robinson, James Alan (to Associated Electrical Industries Ltd.). German Patent 1,188,295. Apr. 4, 1965. Priority date Mar. 8, 1961, Great Britain.

A beryllium alloy composed of 0.5 to 3% titanium or zirconium with the rest beryllium is used for material for parts of gas-cooled nuclear reactors, which must be resistant against carbon dioxide, especially wet carbon dioxide, at high temperatures and high pressures. (Gmelin Inst.)

36992 TUNGSTEN ALLOYS. Andes, George M. (to E. I. du Pont de Nemours and Co.). U. S. Patent 3,184,304. May 18, 1965. Filed Mar. 16, 1961.

Tungsten-base alloys containing 20–40% by weight of Cr, about 1–25% by weight of Ti, and at least 45% W are resistant to oxidation at temperatures as high as 1200°C. The alloy may also contain 1–10% of a metal or combination of metals selected from the group consisting of Fe, Ni, and Co. The alloys may be prepared by any of several well-known methods. (A.G.W.)

36993 REFRACTORY ARTICLES. Taylor, Kenneth M. (to The Carborundum Co.). U. S. Patent 3,189,472. June 15, 1965. Filed Feb. 3, 1961.

Oxidation resistance of dense silicon carbide bodies at elevated temperatures is improved by addition of metals selected from the group of W, Cr, Fe, Hf, Ta, Ti, Zr, and

Mo. The metals may be added singly or in admixture, as elemental metals, or as compounds of the metals. Preferably 2-10% by weight of metal is used. Silicon carbide bodies with the added metals are resistant to oxidation at temperatures as high as 1850°C. (A.G.W.)

Fabrication

Refer also to abstract 38196.

36994 (AMRA-TR-64-50) A STUDY OF THE EFFECT OF HEAT TREATMENT ON THE MICROSTRUCTURE AND PROPERTIES OF SPRAYED MOLYBDENUM. Sellers, David J.; Levy, Milton (Army Materials Research Agency, Watertown, Mass. Materials Engineering Div.). Dec. 1964. 15p. CFSTI.

The effect of sintering on the microstructure, mechanical and physical properties of free-standing, oxyacetylene and arc-plasma-sprayed molybdenum bodies was studied. Significant increases in tensile strength, modulus of elasticity, density, and purity of sprayed molybdenum were achieved by a hydrogen sinter. A microstructure similar to recrystallized molybdenum sheet was obtained. (auth)

36995 (BDX-613-68) EFFECTS OF SURFACE PREPARATIONS ON BOND STRENGTH OF MAGNESIUM. Jackson, Lloyd C. (Bendix Corp., Kansas City, Mo.). Apr. 1965. Contract AT(29-1)-613. 22p. (CONF-650903-1) Dep. mn; CFSTI, $1.00 cy, $0.50 mn

From Symposium on Structural Adhesives, Castle Point Station, N. J.

In order to obtain optimum bond strengths with magnesium alloys, equal consideration must be given to the specific alloy, to the method of surface preparation, and to the adhesive. Dimensional tolerances directly influence the selection of a surface preparation to be used on magnesium alloys prior to adhesive bonding. Certain chemical etches are unsatisfactory because they remove too much magnesium. Other surface preparations may cause smut formation to develop to a point that these loose particles may interfere with optimum bond strength. A problem with epoxy adhesives is that the chemical nature of the epoxy formulation appears to have a sensitivity to the surface chemistry condition of a magnesium alloy after a surface preparation has been used on the alloy. Test data recorded in this report compare shear strengths of six alloys after application of six surface preparations and bonding with four types of epoxy adhesives. (auth)

36996 (CEA-Bib-44) ETUDE BIBLIOGRAPHIQUE SUR LES PROCEDES DE JONCTION PAR DIFFUSION. (Literature Survey of Junction Processes Based on Diffusion). Bonnin, Paulette (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1965. 18p. Dep. mn.

The formation of junctions by diffusion in the solid state was studied in the case of materials which are difficult to weld by conventional methods: soldering, brazing, in particular of reactive metals and refractory metals. This literature survey considers the conditions under which junction diffusion may be effected as well as the results obtained and published by various organizations since 1959. (auth)

36997 (CNLM-5245) WELDING AND ANNEALING FACILITY FOR REFRACTORY METALS. Gould, G. L. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). Oct. 1, 1963. Contract AT(30-1)-2789. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A large scale welding and annealing facility for the processing of refractory metal components is described. Within this facility welders perform manufacturing operations on large power system components while clothed in gas tight environmental suits. The atmosphere within the facility consists of pure argon, which is continuously circulated and repurified by a purification system of advanced design. (W.L.G.)

36998 (EURAEC-1296) THE RUSTPROOF PLATING OF HEAVY-GAGE STEELS. Quarterly Report No. 2, October 1-December 31, 1964. (Neratoom, N. V., The Hague (Netherlands); Ghent Rijksuniversiteit (Belgium); and Soudometal, S. A., Brussels (Belgium)). Jan. 18, 1965. Contract 008-63-12 TEEB. 11p. (EUR-2093) Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Progress is reported on the process development for welding stainless steel tapes on a Soudotenax 56 steel base. (W.L.G.)

36999 (NMI-8001.1) STUDY OF METHODS TO CONTROL GRAIN SIZE, PURITY AND TEXTURE IN BERYLLIUM AND BERYLLIUM ALLOYS. Bi-Monthly Letter Report, October-November 1964. Muller, W. C.; Wolff, A. K. (Nuclear Metals, West Concord, Mass.). Dec. 14, 1964. Contract NOw-65-0084-f. 9p.

The program for using the splatcooling process to produce unlayered, fine-grain hot-pressed and/or wrought Be products is described. High-purity material (SSR-grade Pechiney flake Be) will be used, and Cu, Ni, and Fe will be added to increase the critical resolved shear stress on the basal plane. A dummy run using CR flake Be has been started. (D.L.C.)

37000 (NP-15133) FURTHER DEVELOPMENT OF A DUCTILE TUNGSTEN-BASE SHEET ALLOY. Quarterly Progress Report No. 3, November 20, 1964-April 1, 1965. Maykuth, D. J.; Grube, K. R.; Ogden, H. R.; Blocher, J. M. Jr.; Jaffee, R. I. (Battelle Memorial Inst., Columbus, Ohio). Apr. 19, 1965. Contract N600(19)61982. 32p.

Process developments on the W-5Re-2.2ThO_2 alloy have shown that high reductions in rolling at 1600°C result in sheet that shows a high recrystallization temperature and a very fine recrystallized grain size. Superimposing this fabrication schedule on the previously developed consolidation process has resulted in sheet that shows tensile ductility to -40°C. Three grades of pyrolytic tungsten base were procured for fabrication to sheet in a second phase of this program. These have been evaluated for structure, hardness, density, and purity preparatory to rolling studies. (auth)

37001 (ORNL-TM-1165) NICHROME-ALUMINUM JOINING METHOD EVALUATION. Prislinger, J. J. (Oak Ridge National Lab., Tenn.). May 13, 1965. Contract W-7405-eng-26. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A technique was developed in which Nichrome was joined to aluminum without appreciably inhibiting the electrical conductance. The Nichrome served as a heating element in water and the aluminum as the current-carrying lead. The joint was tested and proved satisfactory. The heater was placed into service and performed satisfactorily while operating within the rated wattage. The heater was one of several pieces of equipment used in a series of experiments to determine if localized boiling of water (as might occur on a fuel element) could be detected. These experiments were an attempt to simulate conditions that might occur if boiling took place in the vicinity of a hot spot on a fuel element submerged in water. Boiling was not detected even under the maximum rated load; therefore, the input energy was increased, and later the heater failed. A failure analysis was made, and the findings are reported. Design and material changes have been recommended to improve the heater's life. (auth)

37002 (RSIC-227) THE FABRICATION OF BERYLLIUM. Gerds, A. F.; Boulger, F W. (Battelle Memorial Inst., Columbus, Ohio). May 1964. Contract DA-01-021-AMC-203(Z). 129p.

Currently used methods for fabricating beryllium into sheets, rods, and other forms are summarized. Some of the difficulties that have been encountered in various aspects of fabrication, especially regarding the inherent

brittleness of the metal, are enumerated along with the means that have been used to circumvent these problems. The survey includes 102 references to articles and papers in the unclassified literature, most of them having been published since 1960. (auth)

37003 (UCRL-12487) ELECTRON BEAM DISTILLATION FURNACE FOR REACTIVE METALS: DESIGN CONSIDERATIONS AND OPERATING EXPERIENCE. Bunshah, R. F.; Juntz, R. S. (Lawrence Radiation Lab., Univ. of California, Livermore). May 13, 1965. Contract W-7405-eng-48. 30p. (CONF-650617-2). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From Vacuum Metallurgy Conference, New York.

Electron beam distillation is a highly attractive technique for purification and simultaneous deposition to semi-finished shape (e.g., sheet) for the reactive metals Be, Ti, etc. A description is given of design considerations and operating experience with an electron beam distillation furnace. Distillate contamination sources and methods to minimize them are discussed. The production of titanium sheet is described. The distillate has 100% theoretical density. Microstructure, chemical analysis, and tensile properties of the distillate are given. (auth)

37004 (Y-DA-732) TUNGSTEN POWDER METALLURGY IN THE PRODUCTION OF LARGE CRUCIBLES AND SUSCEPTORS. Googin, J. M.; Greene, H. T.; Guinn, G. R.; Neeley, A. C. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Apr. 20, 1965. Contract W-7405-eng-26. 23p. (CONF-650631-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI

From International Powder Metallurgical Conference, New York.

Because of its refractory properties and relative chemical inertness in certain selected environments, tungsten has been used in a number of crucible and susceptor applications. A description is given of the production of large susceptors, thin-wall crucibles, and crucibles up to 33 inches in diameter and weighing up to 1700 pounds having integral stirring fins. Among the variables described are powder characteristics, isostatic pressing and large isostats, high-temperature sintering (up to 2575°C), and susceptor utilization. (auth)

37005 PREPARATION OF THIN TARGETS FOR IRRADIATION IN CYCLOTRON. Lukas, I. R. Acad. Rep. Populare Romine, Studii Cercetari Fiz., 15: 483-5(1964).

For studying nuclear reactions in cyclotrons, solid targets are used generally under the form of thin sheets, with or without tantalum plates of 4×4 cm^2 and 4×5.5 cm^2, 0.1 mm thickness, the thickness of the layer of deposited substance being between 0.1 μ and 12 μ, according to the experimental requirements. Various methods for preparing these targets are given taking into account particularly the properties of the respective material and thickness requirements. Thus, these targets were prepared through the rolling method, the electrolytic method, method of evaporation in vacuum etc., the technological process being described for each method. (Rumanian Sci. Abstr., Nat. Sci. Vol. I., No. 8, 1964)

37006 FABRICATION OF TUNGSTEN AND TUNGSTEN-25 RHENIUM TUBING. Paper No. SP65-35. Isserow, S.; Hunt, J. G.; Jenkins, R. G.; Friedman, G. I. ASTME, 1965. 11p.

Problems in extrusion and drawing of unalloyed tungsten and Re alloy are discussed including: filled-billet technique, billet design, filler material and extrusion temperatures; re-extrusion technique; preparation of tubing for drawing and techniques applicable to the actual drawing step; and removal of internal extrusion filler in small diameter tubing. (Rev. Metal Lit., Vol. 22, (June 1965))

37007 VARIABLES IN PLASMA SPRAYING. Marynowski, C. W.; Halden, F. A.; Farley, E. P. (Stanford Research Inst., Menlo Park, Calif.). Electrochem. Technol., 3: 109-15(Mar.-Apr. 1965).

The plasma spraying process may be considered to comprise three distinct operations, particle melting, transfer of particles to the substrate, and control of residual stresses in the sprayed coating. In order to obtain dense, reliable coatings, the factors influencing each of these operations must be considered and controlled. Critical spraying parameters are described, and methods of calculating the effect of specific process changes and of experimentally controlling spraying parameters are discussed. (auth)

37008 METALS FOR REACTORS. Mishima, Ryosuke (Tokyo Univ.). Genshiryoku Kogyo, 11: No. 4, 21-6(Apr. 1965). (In Japanese)

Progress in fabrication of metals for reactor use for the past ten years in Japan is reviewed. A large part of these studies was made possible by grants from private industry, and their contributions are acknowledged. Aluminum alloys, magnesium alloys, stainless steel, zirconium alloys, beryllium, other steels, niobium, and hafnium are considered separately particularly with respect to metal fabrication. Corrosion of metals in pure water is of great concern and there are many programs directed at investigating the fundamental nature of this process. Other programs under way include development of analytical methods for special metals and material inspection procedures. (TTT)

37009 MODEL FOR COMPACTION OF CERAMIC POWDERS. Schwartz, E. G.; Weinstein, A. S. (Carnegie Inst. of Tech., Pittsburgh). J. Am. Ceram. Soc., 48: 346-50(July 1965).

The use of the Coulomb yield criterion to describe the compaction of granular material is proposed. Its use is demonstrated by the numerical solution of the stress and displacement equations describing the axisymmetric pressing of a cylindrical compact. The model was applied to the pressing of uranium dioxide pellets; to do so, the shear strength of the pellets was measured as a function of normal stress. These measurements showed an increase of shear strength with normal load and permitted assignment of values of cohesion and angle of internal friction to be used in the Coulomb failure condition. The computed results of die wall friction, normal force at the die wall, and stress distribution in the compact were compared with measured results. (auth)

37010 REVERSIBLE DEPOSITION OF METALS ON SOLID ELECTRODES BY VOLTAMMETRY WITH LINEARLY VARYING POTENTIAL. Mamantov, Gleb (Univ. of Tennessee, Knoxville and Oak Ridge National Lab., Tenn.); Manning, D. L.; Dale, J. M. J. Electroanal. Chem., 9: 253-9(Apr. 1965). (ORNL-P-701).

It was shown by extending the treatment of Berzins and Delahay that for the reversible deposition of metals on solid electrodes by voltammetry with linearly varying potential, the plot of log $(i_p - i)$ vs E approaches linearity over the approximate current range from 0.5 to 0.9 i_p, with the slope equal 2.2 nF/RT. The experimental data for the reduction of Ag(I) in 1M KNO_3 at silver and pyrolytic graphite electrodes, the reduction of Fe(II) in molten LiF–BeF_2 (66 and 34 mole%) and LiF–NaF–KF (46.5–11.5 – 42 mole%) at 500°C and Ni(II) in LiF–NaF–KF (46.5 – 11.5 – 42 mole%) at pyrolytic graphite electrodes, agreed satisfactorily with the theory. (auth)

37011 ZIRCONIUM FILMS FROM TUNGSTEN FILAMENTS. Voigt, J. W. (Monsanto Research Corp., Miamisburg, Ohio). J. Vacuum Sci. Technol., 2: 215-16 (July-Aug. 1965). (MLM-1255J)

A method of obtaining a zirconium coating by resistance heating is given, since it is found that zirconium tends to alloy with common refractories and requires a temperature over 2000°C for evaporation. An easier method is desired because thin films of zirconium and titanium are considered for diffusion bonding of metals. It is found that a weight ratio of 10% zirconium to 90% tungsten can be used to produce a filament wire which gives satisfactory deposition rates if the zirconium melt is quickly cooled to the point of solidication before its evaporation is attempted. This method is described. (J.F.P.)

37012 ATOMIZATION OF MOLYBDENUM IN PLASMA JET. Krasnov, A. N. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 3, 1-5(1965). (In Russian)

The production of Mo spherical powder particles by atomization of Mo wire (1.2 mm in dia) in plasma arc jet using A as plasma gas and W electrode as a cathode is discussed. Considerations for control of the sphericity of Mo particles and their size by manipulation of such factors as feed rate of the Mo wire and of A into plasma zone, arc current and arc gap and diameter of the nozzle feeding the plasma gas are included. Schematic design of the plasma atomizer is presented. (Rev. Metal Lit., Vol. 22, (June 1965))

37013 USE OF ELECTROPOLISHING IN THE PREPARATION OF METALLOGRAPHIC SAMPLES OF REFRACTORY MATERIALS. Finke, Peter. Prakt. Metallog., 1: 143-51(Dec. 1964). (In German)

The preparation of metallographic specimens with defect-free surfaces of refractory metals such as W, Re, Ta, Mo, and Nb, using electrolytic cutting and polishing techniques was studied. Examples of microstructures, small-angle grain boundaries, and dislocation structures are given. (Rev. Metal Lit., Vol. 22, (June 1965))

37014 PRODUCTION MACHINING OF TUNGSTEN. Babel, H. W.; Archer, F. E. Tool Mfg. Engr., 54: 81-4 (Mar. 1965).

Problems caused by brittleness and abrasiveness must be considered in planning techniques and tool materials for machining W. Tool composition technique and geometry are considered, together with tool wear and quality of output. (Rev. Metal Lit., Vol. 22, (June 1965))

37015 INERT-GAS SHIELDED METAL-ARC WELDING OF ZIRCALOY 2. Salter, G. R.; Brain, A. G. Welding Metal Fabric., 33: 19-23(Jan. 1965).

The possibilities of using argon-shielded free flight or short-circuiting arc welding systems for Zircaloy 2, were studied by measuring the burnoff and voltage/frequency relationships and by making photographs of the arc behavior. (Rev. Metal Lit., Vol. 22, (June 1965))

37016 RECRYSTALLIZATION TEXTURES IN NICKEL–TANTALUM ALLOYS. Detert, Klaus; Ziebs, Josef (Technische Universitaet, Berlin). Z. Metallk., 56: 269-72(May 1965). (In German)

In sheet specimens of nickel alloys containing 0.01, 0.1, and 1.0 at. % tantalum, respectively, cold rolled 97.5%, the textures were determined in the as-rolled condition and after heat treatments for primary recrystallization and at 1050°C. The rolling texture of all alloys was of the copper type. The mixed texture, which was to be expected for primary recrystallization, and the cube texture to be expected on grain growth after prolonged annealing were found in the alloy containing 0.01 at. % Ta in all cases. For certain sintering conditions of the alloy containing 0.1 at. % Ta a deviation, was found in that fine precipitates impeded nucleation and led to a coarse-grained microstructure without a preferred orientation. None of the specimens of the alloy containing 1.0 at. % Ta contained the cube texture if the texture after primary recrystallization was influenced by fine precipitates. Rapid heating to a high temperature suppressed the appearance of fine precipitates so that the ordinary development of the cube texture was observed. (auth)

37017 PROCESSING PROCEDURES FOR HIGH PURITY W-25Re ALLOY SHEET. Tarr, C. O. (General Electric Co., Cincinnati). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint AIAA Paper No. 65-610, 10p. $1.00. (CONF-650610-17). ORINS

From American Inst. of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs.

Tungsten with the highest melting point of the refractory metal is used increasingly for high temperature applications. Since tungsten is brittle at low temperatures following recrystallization, rhenium is added to improve the ductility and impart good weldability. This alloy must be properly processed to maintain a low interstitial impurity content, otherwise it is subject to blistering and void formation. The treatment of metal powders to improve purity is difficult; and once purity is achieved it is difficult to maintain. Special processing procedures have been developed for this purpose. Treatment in hydrogen, in a water-vapor atmosphere and in flowing hydrogen, reduces impurities. Closely controlled conditions and care in removing contaminants are necessary for proper processing. (J.F.P.)

37018 TUBE JOINTS. White, William Paul (to United Kingdom Atomic Energy Authority). British Patent 990,438. Apr. 28, 1965. Filed Feb. 18, 1963.

A method is described for joining two tubular metal members each having a grooved sealing face, particularly for joining a steel tube to a Zr or Zr-alloy tube. The tubular members are in screw-threaded engagement with one another or have a collar common to both members adjacent to the faces with a soft metal gasket between the faces. A portion of at least one of the tubular members is permanently deformed in such a manner that the gasket is rendered plastic to effect a seal between the faces. The members are restrained against relative axial movement, and the deformation of the portion of the member is effected by rolled expansion of that portion. The gasket may be of either annular plate or hollow cylindrical form. (B.L.M.)

37019 OPERATIONALLY SAFE BELL FURNACE FOR THE PRODUCTION OF URANIUM. Delange, Maurice; Sauteron, Paul; Vertes, Paul (to Commissariat a l'Energie Atomique). German Patent 1,191,582. Apr. 22, 1965. Priority date July 6, 1962, France.

A safe bell furnace is described for the production of uranium by reducing uranium tetrafluoride with magnesium. It consists of a crucible of refractory material containing the reaction mixture and a removable bell slipped over the crucible. The height of the crucible is adjustable and the bell, which sits tight on a fixed base plate, is equipped with heating and safety means for carrying out and controlling the reaction. (Gmelin Inst.)

37020 METHOD FOR THE PRODUCTION OF AN ESSENTIALLY FLAT FUEL ELEMENT FOR NUCLEAR REACTORS. Stohr, Jacques Andre; Gauthron, Maurice (to Commissariat a l'Energie Atomique). German Patent 1,192,332. May 6, 1965. Priority date Aug. 21, 1958, France.

The method given is for the production of fuel element plates, which contain oxide fuel pellets uniformly distributed over the area of the plates, positioned in bays provided between two plates sealed by point welding, and thermally bonded to the plates. (Gmelin Inst.)

37021 RUBBER PRODUCTS RESISTANT TO RADIATION DAMAGE. Anderson, Herbert R. Jr. (to Phillips Petroleum Co.). U. S. Patent 3,175,992. Mar. 30, 1965. Filed Aug. 21, 1958.

A method is described for reducing damage to rubber when subjected to irradiation in which the mixture of rubbery polymer of butadiene and styrene (100 parts by weight of the polymer) is vulcanized in the presence of a sulfur containing compound (5 to 10 parts by weight). The product exhibits less change in modulus than the same product without the sulfur additive. (B.L.M.)

37022 APPARATUS FOR VACUUM MELTING AND CASTING METALS. Smurthwaite, John William (to United Kingdom Atomic Energy Authority). U. S. Patent 3,188,702. June 15, 1965. Priority date Sept. 21, 1959, Great Britain.

An apparatus for vacuum melting and casting metallic U includes high-frequency induction coils defining a heating cavity, a melting crucible assembly disposed in the cavity and having a bottom pouring outlet, a supporting structure for the heating cavity, a mold assembly for receiving poured metal, and a removable vacuum sealing envelope enclosing all the preceding equipment. An evacuation duct connects a top extract hood to a vacuum source. The crucible assembly is supported on a carrier so as to be insertable into

and withdrawable from the heating cavity on removal of the sealing envelope. Means are provided for conducting the pouring operation from outside the envelope. (A.G.W.)

37023 METHOD FOR FABRICATING SELF MODERATING NUCLEAR REACTOR FUEL ELEMENT. Dudek, Joseph A.; Ried, Edward L. (to U. S. Atomic Energy Commission). U. S. Patent 3,197,389. July 27, 1965.

The fabrication process comprises the steps of (1) providing an electrically conductive core material, (2) electrophoretically depositing on said core material a radioactive element-containing substance so as to provide a porous layer of said substance, and (3) electrolytically depositing an electrically conductive material in the pores and on the surface of said substance layer so as to provide a matrix of conductive material containing said substance interspersed therethrough. (AEC)

37024 METHOD OF FABRICATING A COMPOSITE NUCLEAR FUEL CORE ELEMENT. Hammond, J. P.; Watts, T. D. (to U. S. Atomic Energy Commission). U. S. Patent 3,198,856. Aug. 3, 1965.

A method is given for fabricating a nuclear fuel core element having a non-uniform distribution of fuel across its width. A metal powder containing a nuclear fuel is charged into a die and its upper surface is shaped to a desired contour. A second metal powder containing a neutron poison is then placed over the first layer of powder and the two layers are pressed. (AEC)

37025 CLADDING PROCESS. Walker, David E.; Noland, Robert A. (to U. S. Atomic Energy Commission). U. S. Patent 3,200,491. Aug. 17, 1965.

A process is given for cladding a uranium-metal-containing core with zirconium, titanium, molybdenum, or vanadium metal. The process consists of framing the core with a strip of cladding metal of the same thickness as the core, sandwiching the framed core including the frame between plates of cladding metal, and simultaneously moving a rolling pressure and an intermittent electrical potential along the entire length, through the entire thickness and over the entire width of the assembly from opposite sides, allowing cooling between pressure-electricity applications to avoid melting of the metals. The thickness of the assembly is reduced by the process and a continuous bond is formed between the core, the strip, and the plates. (AEC)

37026 METHOD FOR CONTROLLING THE COMPOSITION OF URANIUM CARBIDE. Webb, Bradley A.; Koenig, Nathan R. (to U. S. Atomic Energy Commission). U. S. Patent 3,202,586. Aug. 24, 1965.

A uranium carbide nuclear reactor fuel element is designed having a carburizable metal cladding stabilized against carburization by carbon transfer from the fuel material. The fuel element comprises, in combination, a carbon-stable nuclear reactor fuel material consisting essentially of stoichiometric uranium monocarbide containing a composition selected from the class consisting of metal carbide and metal–uranium alloy formed by respective reaction with initially present nonstoichiometric uranium carbide selected from the class consisting of hyper- and hypo-stoichiometric uranium carbide, respectively, and a carburizable metal cladding for said fuel material. (AEC)

Properties and Structure

Refer also to abstracts 36767, 37516, and 37738.

37027 (64-RL-3540M) SUPERCONDUCTIVE INTERMETALLIC COMPOUNDS. Roberts, B. W. (Research Lab., General Electric Co., Schenectady, N. Y.). Jan. 1964. 54p.

Superconductive intermetallic compounds (excluding those containing elements D, H, B, C, N, O, and S) are reviewed with emphasis on the available parameters relating to electronic properties. Substantial data now exist to support the BCS prediction that high densities of states at the Fermi surface lead to high superconductive critical temperatures and are the physical basis for Matthias' rules. In accord with this is the existence of superconductivity in most of the known Cr_3O-type (β-W) compounds. Also, the hexagonal and cubic Laves phases, α-Mn-type compounds, and the sigma phases are frequently found to be superconductive. These structure types are sometimes referred to as "electron compounds." The critical temperatures are highest for compounds with valence electron-to-atom ratios of about 4.7. A secondary peak occurs at about 6.6. The critical temperature in some cases is sharply dependent upon mean atomic volume and the valence electron density. Promise of greater understanding of intermetallic compound electronic properties lies in more detailed knowledge of their band structures, and this knowledge appears to be developing rapidly. (auth)

37028 (BDX-613-69) THERMAL CHARACTERISTICS OF SOME RIGID URETHANE FOAMS. Smith, Clifford H. (Bendix Corp., Kansas City, Mo.). Apr. 7, 1965. Contract AT(29-1)-613. 12p. (CONF-650902-1). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From American Chemical Society, 150th National Meeting, Atlantic City.

Experimental studies were made of the thermal characteristics for three rigid urethane foam formulations, one based on toluene diisocyanate (TDI), one on polymethylene polyphenylisocyanate (PAPI), and one on a combination of the two (TDI-PAPI). The methods used include the measurement of compressive strength at high temperatures, thermogravimetric analysis, differential thermal analysis, heat aging, and nitrogen analysis. The results show that the TDI foam has little compressive strength beyond 140°C and loses weight rapidly above 225°C, while the other two foams have adequate strength to higher temperatures (up to 235°C) and do not lose weight below 300°C. Some possible reasons for the good thermal stability of PAPI-based foams are discussed. (D.L.C.)

37029 (CNLM-4267) CREEP RUPTURE DATA FOR Cb-1 Zr ALLOY. Stewart, J. R.; Rowe, G. H. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). Sept. 28, 1962. Contract AT(30-1)-2789. 31p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Data for the average 1000, 5000, and 10,000 hour rupture and creep strength properties at 1600 to 2200°F are summarized. (W.L.G.)

37030 (GEMP-47A, pp 27-84) HIGH-TEMPERATURE REACTOR MATERIALS RESEARCH. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Creep-rupture tests of arc-cast tungsten were completed at several stress levels at temperatures of 1600, 2000, 2200, 2400, 2600, and 2800°C; in addition, a test of this material at a stress of 0.21 kg/mm^2 at 3000°C was successfully completed. Values of the time required to obtain certain percent elongations are presented for arc-cast tungsten with stress-rupture and second-stage creep behavior correlated in the usual manner. Particular emphasis in these tests was given to an analysis of first-stage creep behavior; a parabolic creep law with an exponent of 0.6 seems to be followed fairly exactly at all temperatures evaluated to date. Arc-cast molybdenum rod, creep-rupture-tested at 2200°C, was analyzed by x-ray diffraction and optical microscopy. Both techniques showed a high degree of polygonization for the high-stress, short-time-to-rupture specimens, with a decrease occurring in the amount of polygonization as the stress was decreased. Back-reflection photographs of longitudinal sections reveal that the orientation was primarily [001] with a strong ⟨11⟩ directionality along the axis of applied stress. An electro-optical extensometer was evaluated for the purpose of measuring creep automatically at elevated temperatures. Excellent agreement was noted for arc-cast molybdenum when the results were compared to data previously obtained for the same material and tested at the same conditions. First-stage creep data for arc-cast molybdenum were analyzed on the basis of the conventional parabolic creep law, $\epsilon =$

$bt^m + \epsilon_0$. Values of b, ϵ_0 and m (constants) were determined for all the tests performed to date with the value for the exponent, m, approximating 0.65. The quality and apparent reliability of W–25Re sheet purchased from commercial vendors was generally unsatisfactory for advanced reactor applications. A major defect observed in the sheet was edge laminations believed attributable to trimming operations. Large areas of the sheet were rejected due to internal defects detected by ultrasonic testing. Very poor surface texture and thickness control were observed for much of six lots of material evaluated. Room-temperature bend tests conducted after holding test pieces at temperatures up to 3000°C (in H_2) showed the powder-metallurgy sheet to be generally more ductile than arc-cast process sheet. Creep-rupture tests of twelve W–Re–Mo alloys were performed at 1600°C and a stress of 4.22 kg/mm^2 to evaluate the effect of varying the rhenium content from 26 to 29 percent and the molybdenum content from 0 to 20 percent. The W–26Re alloy had the longest rupture life and was the most creep-resistant. Specimens of W–28Re and W–29Re, some of which contained 10 percent molybdenum, showed a significant first-stage creep whereas all other specimens showed little or no first-stage creep. The same twelve W–Re–Mo alloys were given room-temperature bend ductility tests after holding for periods to 100 hours in the 1200 to 2600°C range. After holding at 2600°C, the ternary W–Re–Mo alloys developed more bend ductility than binary W–Re alloys. As anticipated, bend ductility and hardness values throughout the series were basically a function of rhenium content with molybdenum acting to lower hardness and increase ductility. Ruthenium was shown to increase the ductility of chromium with the reaction proportional to the electron-to-atom ratio of the alloy. Rhenium has a lower ductilizing effect than ruthenium as a chromium addition on an atom-to-atom basis. Molybdenum added to chromium with ruthenium present as a ductilizing addition had no readily observable influence on ductility of the ternary alloy. (auth)

37031 (GEMP-47A, pp 101-6) HIGH-TEMPERATURE THERMOCOUPLE AND ELECTRIC MATERIALS RESEARCH. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

The thermoelectric potentials to 1800°C of 12 materials with low neutron-capture cross sections indicate Mo, Mo–1Ru, and Mo–1 Os versus Nb have merit as thermocouples to 1200°C and possibly higher by modifying the Nb. The electrical resistivity of ThO_2 and BeO is influenced by oxygen partial pressure at temperatures above 1400°C. A Nb-to Lucalox graded seal withstood 100 thermal cycles between 650 and 1450°C at heating and cooling rates of 300°C per minute. (auth)

37032 (LA-DC-6580) DENSITIES OF SOME LOW MELTING CERIUM ALLOYS. Perkins, R. H.; Geoffrion, L. A.; Biery, J. C. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1962]. Contract W-7405-eng-36. 44p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Densities of cerium metal and several low melting binary cerium alloys were measured over the range 25–800°C. A volumeter, using NaK as working fluid, was used to obtain the data. The cerium, Ce–Co, Ce–Ni, and Ce–Cu alloys all exhibited an increase in density on melting, while a Ce–Mn alloy expanded on melting. (auth)

37033 (LAMS-3017) RADIATIVE AND CONDUCTIVE OPACITIES AND MONOCHROMATIC ABSORPTION COEFFICIENTS FOR IRON AND ALUMINUM. Cox, Arthur N. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Apr. 1962. Contract W-7405-eng-36. 118p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Reported are tentative data on: the iron opacity in the temperature range of 0.1 to 2.0 kilovolts and the density range 1×10^{-3} to 3×10^2 g/cm^3; iron monochromatic absorption coefficients and opacities in the temperature range of 0.002 to 1.0 kilovolt with certain selected densities; and the aluminum monochromatic absorption coefficients and opacities at the same temperature-density points as for the iron monochromatic absorption data. (auth)

37034 (N64-27085) EVALUATION OF D-43 COLUMBIUM ALLOY (Cb–10W–1Zr–0.1C). Baggerly, Roy G.; Torgerson, R. T. (Boeing Co., Seattle, Wash.). Feb. 3, 1964. Contract 8-23542-5548-63878. 27p. (D-2-20275-1)

The evaluation indicates D-43 is a heat treatable alloy with potentially useful strength in the temperature range of 2000 to 3000°F. The alloy displayed good formability at room temperature, subzero transition temperature and good weldability with the tungsten-arc inert-gas process. The welds are characterized by good strength but marginal ductility in the as-welded condition. The oxidation resistance of Disil-coated D-43 is relatively poor at 2700 and 3000°F compared to other high-strength Nb alloys. It is concluded that marginal weld ductility, poor oxidation resistance with the Disil coating, and questionable thermal stability are potential disadvantages to use of D-43 alloy. (auth)

37035 (N64-29195) INVESTIGATION OF MECHANICAL PROPERTIES OF CHROMIUM, CHROMIUM–RHENIUM, AND DERIVED ALLOYS. Quarterly Progress Report No. 17. Gilbert, A.; Reid, C. N. (Battelle Memorial Inst., Columbus, Ohio). June 31, 1964. 12p. (NASA-CR-58288). CFSTI, $1.60 cy.

The crystallography of slip and cleavage in Mo–35Re crystals was studied. Twinning was completely suppressed, and slip on {112} planes was observed at 415 and 28°C in a crystal with its longitudinal axis near to (001). Slip occurred on systems that were almost ideally oriented for the maximum shear stress. Brittle cleavage fractures of similar crystals were performed by impact at a temperature near 80°K. The fracture propagated largely along {112}-type twin-matrix boundaries. (auth)

37036 (N64-33085) EFFECTS OF PURITY AND STRUCTURE ON RECRYSTALLIZATION, GRAIN GROWTH, DUCTILITY, TENSILE, AND CREEP PROPERTIES OF ARC-MELTED TUNGSTEN. Klopp, William D.; Raffo, Peter L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1964. 49p. (NASA-TN-D-2503). CFSTI, $1.25 cy.

The properties of five lots of arc-melted tungsten were characterized by chemical analyses, recrystallization and grain growth behavior, low-temperature ductility at 200 to 750°F, and high-temperature tensile and creep properties at 2500 to 4140°F. Purity appeared to affect the rates of recrystallization and grain growth; the rates tended to decrease with increasing metallic impurity content. The high-temperature tensile and creep behavior was significantly influenced by structure. Yield strength, ultimate tensile strength, parabolic work-hardening coefficient, and creep strength increased with decreasing grain size. (auth)

37037 (N64-33174) VAPORIZATION OF THERMIONIC REFRACTORY MATERIALS. Status Report No. 11, March 1, 1964 - May 31, 1964. Szwarc, R.; Plante, E. R.; Diamond, J. J. (National Bureau of Standards, Washington, D. C.). 12p. (NBS-8508; NASA-CR-58774). CFSTI, $1.00 cy.

A comparison is made of the data of Langmuir and Zwikker in this study on the vaporization rate of tungsten. Measurements of the vaporization rate of an oriented single-crystal tungsten specimen were obtained, and it was concluded that if a difference between the vaporization rate of polycrystalline tungsten and single-crystal oriented tungsten exists, this difference must be the same magnitude or smaller than the experimental errors involved in the measurements. (CFSTI)

37038 (N64-33326) VAPORIZATION OF THERMIONIC REFRACTORY MATERIALS. Status Report No. 12, June 1, 1964 - August 31, 1964. Szwarc, R.; Plante, E. R.; Diamond, J. J. (National Bureau of Standards, Washington, D. C.). Aug. 31, 1964. 8p. (NBS-8556; NASA-CR-59273). CFSTI, $1.00 cy.

The data from studies by Sherwood, Langmuir, Stull, and Sinke concerning the rate of sublimation of rhenium are discussed briefly. The results of a semiquantitative spectrochemical analysis of rhenium are listed, and the data

indicate that no contaminant of any consequence is present in the material supplied. (CFSTI)

37039 (NASA-CR-54393) GENERATION OF LONG TIME CREEP DATA OF REFRACTORY ALLOYS AT ELEVATED TEMPERATURES. Quarterly Report No. 7, December 26, 1964–March 26, 1965. Sawyer, J. C.; Philleo, C. H. (TRW Equipment Labs., Thompson Ramo Wooldridge Inc., Cleveland, Ohio). Apr. 28, 1965. Contract NAS 3-2545. 40p.

Ultra-high vacuum creep data are presented for tungsten, tungsten–25% rhenium, TZM and TZC molybdenum alloys, and AS-30 niobium alloy. TZC alloy exhibits the greatest creep strength of the turbine alloys examined and was selected for the initial 10,000 hour creep tests. (auth)

37040 (NP-15118) THE THERMAL-MECHANICAL BEHAVIOR OF STRONTIUM ZIRCONATE. Bimonthly Progress Report No. 3, February 1–April 1, 1965. Funk, J. E.; Nemeth, J.; Tinklepaugh, J. R. (State Univ. of New York Coll. of Ceramics, Alfred Univ.). Contract NOw-65-0131-d. 25p.

An addition of 15 mol. % calcium zirconate to strontium zirconate results in a material that has a modulus of rupture of about 27,800 psi as compared to strontium zirconate at 13,000 psi. This solid solution also exhibits the yield characteristics previously observed in strontium zirconate. Research has continued on the strengthening of strontium zirconate by various cation additions. The thermal expansion characteristics in the various crystallography axis have been carefully examined and it is concluded that sufficient anisotropy does not exist to cause microcracks in strontium zirconate. Strontium hafnate has been synthesized and is being examined. (auth)

37041 (NP-15174) RESEARCH AND DEVELOPMENT ON NEW PROCESSES OF PRODUCING DUCTILE MOLYBDENUM. Final Report, November 1, 1961–October 31, 1964. Semchyshen, M.; Barr, Robert Q.; Coldren, A. Phillip (Climax Molybdenum Co. of Michigan, Detroit). Apr. 30, 1965. Contract NOrd-15915. 139p.

Studies were conducted on a laboratory scale with the objective of lowering the transition temperature of arc-cast molybdenum. One of the approaches which was pursued involved experiments which attempted to improve the purity of arc-cast molybdenum. Another second group of experiments involved additions of elements which would tend to mitigate the deleterious effect of interstitial impurities. Molybdenum powder was prepared by reducing high-purity MoO_2Cl_2 prepared under laboratory conditions, by chlorinating MoO_2, and then converting the dioxydichloride to ammonium polymolybdate. The latter was reduced to metallic powder in palladium-diffused hydrogen. The powder was consolidated by non-consumable arc-melting, followed by rolling to sheet. Although the purity of the powder was extremely high, the ductility of the rolled sheet was not particularly good owing to contamination that occurred during melting and to the small amount of total reduction achieved by rolling. An attempt was made to purify molybdenum in the solid state in high-purity atmospheres at elevated temperatures. The purity of the solid samples was monitored by hardness and bend tests and by chemical analyses. Limitations of the laboratory equipment are discussed, and recommendations are made for further work in the area of solid-state purification. Vacuum-arc-cast ingots were prepared using powder that had been treated in palladium-diffused hydrogen, then transferred to the melting furnace without exposure to air. Additions were made to the ingots so that various deoxidizing agents could be studied. Unnotched Charpy impact specimens prepared from bars which had been deoxidized by thorium or neodymium sustained 30 ft-lb of energy without fracture at a temperature of −100°F; the best carbon-deoxidized bar subjected to similar test condition absorbed 30 ft-lb without fracturing at a temperature of −75°F. A series of ingots was prepared with small additions of aluminum, chromium, or nickel. Rolled bar stock from an ingot to which chromium had been added yielded unnotched Charpy impact specimens which absorbed 30 ft-lb of energy without fracturing at a temperature of −200°F. An evaluation was made of molybdenum produced at several other laboratories. None of the submitted samples was considered high in purity. (auth)

37042 (ORNL-3778(p.4-6)) EFFECTIVE MAGNETIC FIELD AND ISOMER SHIFT FOR Au–Ni ALLOYS AS A FUNCTION OF COMPOSITION. Roberts, L. D.; Obenshain, F. E.; Thomson, J. O.; Robinson, W. K.; Newbolt, W. B. (Oak Ridge National Lab., Tenn.).

The hyperfine structure (hfs) coupling and isomer shift for Au dissolved in Ni have been investigated as functions of composition. Within experimental error, the hfs coupling is found to be proportional to the alloy magnetic moment, and the isomer shift is found to be proportional to the atomic fraction of Au. (auth)

37043 (ORNL-P–1394) HIGH-TEMPERATURE CHEMICAL STABILITY OF REFRACTORY-BASE ALLOYS IN HIGH VACUUM. Bourgette, D. T. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 23p. (CONF-650617-1) Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Vacuum Metallurgy Conference, New York.

Evaporation losses of refractory-base alloys having the commercial designations T-111, FS-80, FS-85, B-66, C-129Y, and D-43 were determined for various periods of time at temperatures between 1200 and 1500°C. The experimental pressures ranged from 7×10^{-7} to 6×10^{-10} torr. In general, there were no serious evaporation problems associated with these alloys, especially at temperatures of 1200 to 1300°C. The alloys that exhibited the greatest evaporation losses contained the higher vapor-pressure elements such as vanadium, zirconium, and hafnium. For example, B-66, the most volatile alloys studied, lost 1.70 mg/cm^2 at 1500°C and 7×10^{-9} torr in 316 hr, while at 1200°C and 6×10^{-10} torr a weight loss of 0.077 mg/cm^2 was measured in 513 hr. Vanadium and zirconium losses contributed 95% of the total weight loss. Evaporation occurred only at the surfaces; no subsurface voids were detected nor did evaporation occur at any preferential sites, such as grain boundaries or impurity inclusions at or near the surfaces. The total weight change in the specimens appeared to be pressure and composition dependent. At 1200 to 1300°C and 10^{-7} torr, the niobium-base alloys FS-80 and D-43, containing only zirconium as the evaporating element, showed a weight gain, while at the same temperature at 10^{-9} torr a weight loss was observed. This behavior is attributed to interstitial contamination at 10^{-7} torr and purification at 10^{-9} torr. For those alloys containing more than one evaporating species, such as B-66 and C-129Y, a weight loss was observed at both the high and low test pressures at 1500°C. The evaporation losses in these cases overshadowed the changes in the interstitial contents. Changes in the interstitial concentrations were dependent on the pressure. At 1500°C and pressures of 10^{-4} torr or lower, carbon was retained while oxygen, nitrogen, and hydrogen were evolved. At a higher pressure of 10^{-7} torr and 1500°C, carbon was lost while the oxygen and nitrogen contents showed an increase. It is believed that the reaction of carbon and oxygen resulted in the loss of carbon at the higher pressures, while at 10^{-9} torr insufficient oxygen was present to appreciably reduce the carbon concentrations. (auth)

37044 (RL-SA-20) EFFECTS OF HIGH TEMPERATURE EXPOSURE ON CONCRETE. Davis, Harold S. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Feb. 16, 1965. Contract AT(45-1)-1350. 3p. (CONF-650602-2). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

A brief discussion is presented on the effects of high temperature and thermal cycling on the strength properties of concrete of the portland cement type. It is pointed out that while concrete usually retains its compression strength at temperatures up to 800°F, other considerations (aggregates, dehydration, etc.) may limit the maxi-

mum temperature to less than 200°F. Strength data at various temperatures are tabulated for a typical structural concrete used at Hanford. (D.L.C.)

37045 (UCRL-7202) HIGH TEMPERATURE PLASTIC DEFORMATION OF POLYCRYSTALLINE BERYLLIUM OXIDE. Barmore, Willis L.; Vandervoort, Richard R. (Lawrence Radiation Lab., Univ. of California, Livermore). June 25, 1964. Contract W-7405-eng-48. 30p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

High density specimens were plastically deformed under four-point transverse bending. Tests were conducted in vacuum in the temperature region 1400 to 1700°C under stresses ranging from 1000 to 4500 psi. The activation energy for creep was 99.0 kcal per mole. Creep rate was directly proportional to the applied stress and inversely proportional to the square of the grain diameter. The deformation behavior is ascribed to a Nabarro-Herring type mechanism. Results show that creep in tension and compression were the same. (auth)

37046 (UCRL-12357) SOME MECHANICAL PROPERTIES OF URANIUM-10 WT PERCENT MOLYBDENUM ALLOY UNDER DYNAMIC TENSION LOADS. Hoge, K. C. (Lawrence Radiation Lab., Univ. of California, Livermore). Feb. 1, 1965. Contract W-7405-eng-48. 38p. Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

Dynamic tensile tests were conducted on uranium–10 wt % molybdenum alloy in as-cast and wrought conditions. Carbon content was varied from 71 to 800 ppm. Heat treatment was also varied. Tests were conducted on a universal testing machine at strain rates of 4.8×10^{-5} and 0.057 in./in./sec and on a modified Dynapak at strain rates up to 100 in./in./sec. Tests were run from 75 to 600°F. Relatively low strain rates were used to determine the susceptibility to stress corrosion while the higher strain rates demonstrated the sensitivity of various mechanical properties to strain rate effects. (auth)

37047 (UCRL-16075) HIGH PRESSURE INVESTIGATIONS OF SULFUR. Harris, Robert E.; Jura, George (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 1965. Contract W-7405-eng-48. 10p (CONF-640706-1). Dep (mn); $1.00(cy), 1(mn) CFSTI

From Sulfur Conference, Berkeley, Calif.

The high pressure investigations on sulfur are reviewed. The only unusual property exhibited by sulfur under pressure is the transformation to the rubbery form when the crystals are subjected to shear under pressure, presumably at pressures as low as 10 kbars. The electrical properties show that the energy gap in sulfur decreases with pressure, but that the element has not been found to become metallic even at pressures as high as 400 kbars. (auth)

37048 (WVT-6431) HYDROSTATIC PRESSURE INDUCED PLASTIC FLOW IN POLYCRYSTALLINE METALS. Davidson, T. E.; Uy, J. C.; Lee, A. P. (Watervliet Arsenal, N. Y. Benet R and E Labs.). Dec. 1964. 20p. CFSTI.

The effects of hydrostatic pressures to 26 kbars on the microstructure of polycrystalline Cd, Zn, Bi, Sn, Zr, Mg, Cu, and Fe were examined. Pressure induced microscopic plastic flow in the form of boundary migration, slip, multiple slip or twinning were observed either singly or in combination in Cd, Zn, Bi and Sn. No deformation was observed in Zr, Mg, Cu, and Fe. The occurrence of such deformation, in terms of its intensity and initiation pressure, relates directly to the degree of anisotropy in the linear compressibility. Pressure cycling does not significantly affect the residual tensile properties of a Zn alloy which exhibits pressure-induced deformation similar to that of pure Zn. (auth)

37049 (FTD-TT-63-1018) SYSTEMATISM OF BINARY INTERMETALLIC PHASES. Kripyakevich, P. I.; Cherkashin, E. E. (Translated from Izv. Sektora Fiz.-Khim. Analiza, Inst. Obshch. Neorgan. Khim., Akad. Nauk SSSR, 24: 59-123(1954). 84p. (CFSTI).

A systematic review is presented of all known binary intermetallic phases. The various ways of systematization (structural, physical, and chemical) are discussed. Tables of the phases are included: (1) phases with known structure type and class, (2) phases with known structure but not included in specific classes, (3) phases with incompletely known structure, and (4) phases with unknown structure. (D.L.C.)

37050 THE CRYSTAL STRUCTURES OF V_2C AND Ta_2C. Bowman, Allen L.; Wallace, Terry C.; Yarnell, John L.; Wenzel, Robert G.; Storms, Edmund K. (Los Alamos Scientific Lab., N. Mex.). Acta Cryst., 19: 6-9 (July 10, 1965). (LA-DC-6549)

A neutron diffraction study of V_2C and Ta_2C showed that V_2C has the L'3 structure, while Ta_2C has the C6 cadmium iodide antitype structure. The Ta_2C space group is $P\bar{3}m1$ (D_{3d}^3). Two tantalum atoms are in 2(d) with z = 0.2537 and one carbon atom is in 1(a). (auth)

37051 STRUCTURAL CHANGES CAUSED BY THE NEUTRON IRRADIATION OF σ PHASES. Wilson, C. G.; Parselle, M. H. (Royal Military Coll. of Science, Swindon, Wilts., Eng.). Acta Cryst., 19: 9-14(July 10, 1965).

The effects of fast neutron bombardment on the structure of three σ phases, Mo-55%Re, Mo-68%Re, and Mo-50%Re, were studied by x-ray diffractometry. Radiation damage consisting of line broadening, changes in unit-cell dimensions, and disordering were observed, the magnitude of the effects depending on the total fast-neutron dose. It is suggested that the irradiation creates clusters of defects causing line broadening and that the change in unit-cell size is caused by the disordering of atoms of different radii. (auth)

37052 CUBIC PHASES OF THE Th_3P_4 TYPE IN THE RARE EARTH SULFIDES, SELENIDES, AND TELLURIDES L_2X_3 AND L_2X_4, AND IN THEIR ML_2X_4 COMBINATIONS WITH MX SULFIDES AND SELENIDES OF CALCIUM, STRONTIUM, AND BARIUM. FORMATION AND CRYSTALLINE PROPERTIES. Flahaut, Par J.; Guittard, M.; Patrie, M.; Pardo, M. P.; Golabi, S. M.; Domange, L. (Faculté de Pharmacie de Paris, France). Acta Cryst., 19: 14-19(July 10, 1965). (In French)

A survey was made of the crystal structures of the rare earth sulfides, selenides, and tellurides of composition L_3X_4 and L_2X_3 having the Th_3P_4 structure type, and of the existence of homogeneity ranges between these two limits of composition; also of the crystal structures of the ML_2X_4 compounds (L = rare earth, M = Mg, Ca, Sr, Ba and X = S or Se), of the Th_3P_4-type compounds of this composition and of homogeneity ranges between ML_2X_4 and L_2X_3. It was not possible to prepare definite compounds of composition MgL_2S_4, MgL_2Se_4 or CaL_2Se_4 with the first elements of the rare earth series but domains of homogeneity exist between these and L_2X_3. (auth)

37053 MULTIPLE PHASE FORMATION IN THE BINARY SYSTEM Nb_2O_5–WO_3. I. PREPARATION AND IDENTIFICATION OF PHASES. Roth, R. S.; Wadsley, A. D. (C.S.I.R.O., Melbourne). Acta Cryst., 19: 26-32 (July 10, 1965).

An equilibrium study at 1300–1400°C of the system Nb_2O_5–$1Nb_2O_5:1WO_3$ led to the identification of five compounds in what had been previously reported as a region of solid solution. Three phases, $WNb_{30}O_{78}$, $WNb_{12}O_{33}$, and $W_5Nb_{16}O_{55}$ are monoclinic, while the remaining two, $W_3Nb_{14}O_{44}$ and $W_5Nb_{18}O_{68}$, are tetragonal. Each phase is characterized, and it is shown that the existence of not more than two of them could have been predicted by crystallochemical arguments. (auth)

37054 MULTIPLE PHASE FORMATION IN THE BINARY SYSTEM Nb_2O_5–WO_3. II. THE STRUCTURE OF THE MONOCLINIC PHASES $WNb_{12}O_{33}$ AND $W_5Nb_{16}O_{55}$. Roth, R. S.; Wadsley, A. D. (C.S.I.R.O., Melbourne). Acta Cryst., 19: 32-8(July 10, 1965).

The unit-cell dimensions of $WNb_{12}O_{33}$ are a = 22.37, b = 3.825, c = 17.87 Å, β = 123.6°, space group C2. The structure consists of ReO_3-type blocks of Nb–O octahedra three wide, four long, and infinite in the third direction,

which are joined by sharing edges, and with tetrahedrally coordinated W atoms ordered at the junctions of every four blocks. $W_5Nb_{16}O_{55}$ has the dimensions a = 29.79, b = 3.820, c = 23.08 Å, β = 126.5° and the space group C2. It also contains octahedral blocks, but of a different size, four wide, five long, and infinite along the third direction. These blocks are grouped as in $WNb_{12}O_{33}$, with W occupying similar tetrahedral positions. The structures of both were deduced by trial-and-error, and refined by two-dimensional Fourier methods. (auth)

37055 MULTIPLE PHASE FORMATION IN THE BINARY SYSTEM $Nb_2O_5-WO_3$. III. THE STRUCTURES OF THE TETRAGONAL PHASES $W_3Nb_{14}O_{44}$ AND $W_3Nb_{18}O_{69}$. Roth, R. S.; Wadsley, A. D. (C.S.I.R.O., Melbourne). Acta Cryst., 19: 38-42(July 10, 1965).

The unit-cell dimensions of $W_3Nb_{14}O_{44}$ are a = 21.02, c = 3.824 Å, space group I4/m or $I\bar{4}$. The structure consists of ReO_3-type blocks of octahedra four wide, four long, and infinite along the fourfold axis, joined by sharing edges and with tetrahedral W atoms at the junctions of every four blocks. $W_3Nb_{18}O_{69}$, with the dimensions a = 26.25, c = 3.813 Å, most probable space group $I\bar{4}$, has an identical structure except that the blocks are five octahedra in width and length. W and Nb are randomized in the octahedral positions of both phases. The structures were deduced by trial-and-error and refined by two-dimensional Fourier methods. (auth)

37056 MULTIPLE PHASE FORMATION IN THE BINARY SYSTEM $Nb_2O_5-WO_3$. IV. THE BLOCK PRINCIPLE. Roth, R. S.; Wadsley, A. D. (C.S.I.R.O., Melbourne). Acta Cryst., 19: 42-7(July 10, 1965).

Four new phases that were found in the $Nb_2O_5-WO_3$ system each contain octahedral blocks of a specific size, joined in a manner that leaves tetrahedral positions for some of the metal atoms. The many ways in which logical structures containing blocks of octahedra can be devised are briefly discussed. These can all be summarized by a general formula containing several independent variables, representing the size of block and its mode of packing. (auth)

37057 CRYSTALLOGRAPHIC DATA FOR YCo_3 AND Y_2Co_{17}. Ostertag, Werner (Wright-Patterson Air Force Base, Ohio). Acta Cryst., 19: 150-1(July 10, 1965).

Studies on the Y and Co phase diagram showed that YCo_3, and Y_2Co_{17} exist as single-phase compounds. The hexagonal unit cell of the YCo_3 structure has the dimensions a = 5.015 and c = 16.28 Å and it contains 6 formula units. The Y_2Co_{17} structure shows one formula unit in the rhombohedral unit cell with a = 5.722 Å and a = 78° 10'. The dimensions for the triply primitive hexagonal cell are a = 8.331 and c = 12.186 Å. Data are tabulated. (P.C.H.)

37058 THE CRYSTAL STRUCTURE OF OSMIUM TETROXIDE. Ueki, Tatzuo; Zalkin, Allan; Templeton, David H. (Univ. of California, Berkeley). Acta Cryst., 19: 157-60(Aug. 10, 1965). (UCRL-11449)

Crystals of OsO_4 are monoclinic, space group C2/c, with 4 molecules in the cell with dimensions a = 9.379, b = 4.515, c = 8.632 Å; β = 116.6°. By least-squares refinement of three-dimensional x-ray diffraction data the molecules are tetrahedral with Os–O = 1.74 Å (uncorrected for thermal motion). The molecular arrangement is approximately cubic closest packing. The intermolecular O–O distances exceed 2.98 Å and are consistent with weak intermolecular forces indicated by the high vapor pressure and low melting point. (auth)

37059 DOUBLE OXIDES CONTAINING NIOBIUM OR TANTALUM. I. SYSTEMS INCLUDING ALKALI METALS. Whiston, C. D.; Smith, A. J. (Univ. of Sheffield, Eng.). Acta Cryst., 19: 169-73(Aug. 10, 1965).

The binary systems $A_2O-B_2O_5$ (A = Li, Na, or K; B = Nb or Ta) and two phases in the system $Cs_2O-Nb_2O_5$ were studied. One new intermediate phase, $Li_2Ta_4O_{11}$, was found, and unit-cell data are reported for most of the 22 double oxides that were observed. These do not include the well-known ABO_3 compounds. Two superstructures of the tetragonal bronze type, with unit cells of three and nine times the ideal cell, were among those found. (auth)

37060 THE CRYSTAL STRUCTURE OF RHOMBOHEDRAL $PuAl_3$. Runnalls, O. J. C.; Boucher, R. R. (Chalk River Nuclear Labs., Ont.). Acta Cryst., 19: 184-6 (Aug. 10, 1965).

The crystal structure is reported for $PuAl_3$ single crystals extracted from aluminum-6 at. % plutonium alloys that had been slow-cooled to 930°C and then quenched to 20°C. The structure is rhombohedral with a_r = 7.879 ± 0.003 Å and α_r = 45.94°, Z = 3 units of $PuAl_3$ per unit cell and probable space group $R\bar{3}m$. The structure can be described as an assembly of close-packed layers each with an Al:Pu atomic ratio of 3:1 and stacked in the sequence ABABCBCACA ··· . Thus the stacking sequence is appreciably different from that of the earlier-reported hexagonal configuration, ABCACBA ··· , which is produced on heating rhombohedral $PuAl_3$ to 1027°C. (auth)

37061 THE CRYSTAL STRUCTURE OF RUBIDIUM URANYL NITRATE: A NEUTRON-DIFFRACTION STUDY. Barclay, G. A. (Univ. of New South Wales, Kensington, Australia); Sabine, T. M.; Taylor, J. C. Acta Cryst., 19: 205-9(Aug. 10, 1965).

The crystal structure of rubidium uranyl nitrate, $RbUO_2(NO_3)_3$, was determined from neutron-diffraction intensities for two zones of reflexions. The light-atom positions were defined more accurately than was possible with x-ray data. The uranium atom is surrounded by eight oxygen atoms at the corners of a distorted hexagonal bipyramid (six nitrate oxygen atoms at 2.48 Å and two uranyl oxygen atoms at 1.78 Å). Each nitrate group acts as a bidentate chelate forming a four-membered ring system. The rubidium atom has twelve oxygen atoms as its near neighbors. (auth)

37062 THE AXIAL EXPANSIONS OF BeO BETWEEN ROOM TEMPERATURE AND 1700°C. Lang, S. M. (Owens-Illinois Tech. Center, Toledo). Acta Cryst. 19: 210-14(Aug. 10, 1965).

The temperature dependencies of the lattice constants of BeO were determined to provide the necessary intermediate data for assigning sample temperatures to high-temperature x-ray powder diffraction experiments. An accuracy of 10°C at temperatures up to at least 1700°C can be attained if precise diffraction measurements are made. The lattice-constant values, used to precalculate diffraction maxima locations at various temperatures, are given by $a_{t_2} = a_{t_1} + \Delta a_{t_2} \pm X_a$ and $c_{t_2} = c_{t_1} + \Delta c_{t_2} \pm X_c$ where t_1 is the room temperature, t_2 is the test temperature, Δa_{t_2} and Δc_{t_2} are defined by $\Delta a_{t_2} = -5.30_3 \times 10^{-4} + 1.87_1 \times 10^{-5}(t_2) + 8.06_4 \times 10^{-9}(t_2)^2$ Å and $\Delta c_{t_2} = -7.27_4 \times 10^{-4} + 2.56_2 \times 10^{-5}(t_2) + 1.26_1 \times 10^{-8}(t_2)^2$ Å, and X_a and X_c are the corrections, calculated from the delta-equations, for the difference between the 28°C room temperature of these experiments and the room temperature at which the lattice constants, a_{t_1} and c_{t_1}, are determined for the user's BeO material. (auth)

37063 AB COMPOUNDS WITH Sc, Y AND RARE EARTH METALS. I. SCANDIUM AND YTTRIUM COMPOUNDS WITH CrB AND CsCl STRUCTURE. Schob, O.; Parthé, E. (Univ. of Pennsylvania, Philadelphia). Acta Cryst., 19: 214-24(Aug. 10, 1965).

The crystal structures of seven new compounds were determined. ScSi, ScGe, ScGa, YGe, and YGa crystallize with the TlI (B33) type (also known as CrB or B_f type) and ScMg and ScAl with the CsCl (B2) structure type. A survey of all known equiatomic compounds and their structures, having Sc, Y, or rare earth metals as one component, is given and an effort is being made to find some general rules that govern the formation of these compounds and their structures. (auth)

37064 COMPARISON OF SCATTERING FACTORS COMPUTED FROM FOUR DIFFERENT ATOMIC MODELS. Cromer, Don T. (Los Alamos Scientific Lab., New Mex.). Acta Cryst., 19: 224-7(Aug. 10, 1965). (LA-DC-6369)

Scattering factors computed from four different atomic

models were compared at various values of sin θ/λ throughout most of the Periodic Table. The differences are discussed in relation to the differences in the atomic models. (auth)

37065 THE CRYSTAL STURCTURE OF COBALT MOLYBDATE, $CoMoO_4$. Smith, G. W. (British Petroleum Co., Ltd., London); Ibers, James A. Acta Cryst., 19: 269-75(Aug. 10, 1965). (BNL-8391)

Cobalt molybdate crystallizes in the monoclinic system, space group $C2/m$, with 8 molecules in a cell of $a = 9.67$, $b = 8.85$, $c = 7.76$ Å, $\beta = 113° 49'$. The structure, which has a marked sub-cell exhibiting almost perfect tetragonal symmetry, was determined by Patterson and Fourier methods and refined by least-squares methods. The oxygen atoms are sixfold coordinated around both cations in a close-packed arrangement of distorted octahedra, based upon the NaCl (or CoO) type structure. However, not all the octahedral holes are filled by the cations; the cations only occupy edge-sharing octahedra in such a way that infinite chains parallel to the c axis are formed. Each chain of filled octahedra is surrounded by other chains of unfilled octahedra. Each of the two independent Co atoms is displaced from the center of its octahedron by about 0.1 Å, with Co–O distances ranging from 2.03 to 2.17 Å and from 2.01 to 2.16 Å; similarly each of the two crystallographically independent Mo atoms is displaced from the center of its octahedron by about 0.4 Å, with Mo–O distances ranging from 1.73 to 2.31 Å and from 1.72 to 2.33 Å. These displacements result in a wide range of inter-cationic distances in the structure. (auth)

37066 STANNIDES AND PLUMBIDES OF Sc, Y, La AND Ce WITH $D8_8$ STRUCTURE. Jeitschko, W.; Parthé, E. (Univ. of Pennsylvania, Philadelphia). Acta Cryst., 19: 275-9(Aug. 10, 1965).

An x-ray investigation was made on alloys with composition (Sc, Y, La, Ce)$_5$(Sn, Pb)$_3$. Six new compounds are reported. The results indicate that the $D8_8$ structure occurs with transition metals of the third to the eighth group as one partner and B elements of the third, fourth, and fifth group as the second component. The structure can accommodate a very wide range of size differences of the participating atoms. The size ratio varies from 0.83 for Ti_5Pb_3 to 1.35 for Y_5Si_3. Data are tabulated. (P.C.H.)

37067 THE CRYSTAL STRUCTURES OF $PuGa_4$ AND $PuGa_6$. Ellinger, F. H.; Zachariasen, W. H. (Los Alamos Scientific Lab., N. Mex.). Acta Cryst., 19: 281-3(Aug. 10, 1965). (LA-DC-6793)

The crystal structures of $PuGa_4$ and $PuGa_6$ as deduced from powder x-ray diffraction patterns are reported. $PuGa_4$ has the $D1_b$ structure (UAl_4 type) with $a = 4.380 \pm 0.001$, $b = 6.290 \pm 0.001$, $c = 13.673 \pm 0.004$ Å. The calculated density is 9.13 g cm^3 and the space group is Imma. The diffraction lines of the $PuGa_6$ pattern correspond to a primitive tetragonal cell with $a = 5.942 \pm 0.001$, $c = 7.617 \pm 0.001$ Å. The cell contains two formula units, given a calculated density of 8.11 g cm^3. The suggested symmetry is P4/nbm. Data are tabulated. (P.C.H.)

37068 SOME NEW INTERMETALLIC COMPOUNDS OF HOLMIUM AND ERBIUM WITH Ag, Au, Pt, Al, In, Tl, AND Ge. Moriarty, J. L.; Gordon, R. O.; Humphreys, J. E. (Lunex Co., Pleasant Valley, Iowa). Acta Cryst., 19: 285-6(Aug. 10, 1965).

Structural data for compounds of Ho and Er with Ag, Au, Pt, Al, In, Tl, and Ge are reported. The phases were identified by indexing the x-ray diffraction powder photographs. The photographs were made of the alloy specimen in either the as melted or annealed condition. Unit cell dimensions for the intermetallic compounds are tabulated. (P.C.H.)

37069 THERMODYNAMICS OF FORMATION OF YTTRIUM–MAGNESIUM INTERMEDIATE PHASES. Smith, J. F.; Bailey, D. M.; Novotny, D. B.; Davison, J. E. (Ames Lab., Ames, Iowa). Acta Met., 13: 889-95(Aug. 1965).

Three intermediate phases occurred in the yttrium–magnesium system. The γ phase was isostructural with CsCl and had a range of homogeneity of ~2 at.%. The δ phase was isostructural with $MgZn_2$ and was essentially invariant in stoichiometry. The ϵ phase crystallized with the α-manganese structure and a limiting stoichiometry of Y_5Mg_{24} at the peritectic temperature; at temperatures below the peritectic decomposition the stoichiometry was more magnesium rich with a range of homogeneity of ~3 at.%. The free energies of phase formation were determined from measurement of magnesium vapor pressures over a series of alloys while the enthalpies of phase formation were determined calorimetrically with a differential acid solution calorimeter. Combination of the data yielded the following values for the thermodynamic functions associated with phase formation respectively of YMg, YMg_2, and Y_5Mg_{24}: $\Delta F^\circ_{298} = -2.9 \pm 0.2$, -3.0 ± 0.2, -1.9 ± 0.2 kcal/g atom; $\Delta H^\circ_{298} = -3.0 \pm 0.3$, -3.4 ± 0.3, -1.8 ± 0.2 kcal/g atom; $\Delta S^\circ_{298} = -0.3 \pm 0.4$, -1.3 ± 0.4, $+0.4 \pm 0.3$ eu/g atom. Both the enthalpy and entropy of formation correlated with the volume contractions, which accompany phase formation. (auth)

37070 DISLOCATION INTERSTITIAL INTERACTIONS IN SINGLE-CRYSTAL TUNGSTEN. Carpenter, S. H.; Baker, G. S. (Aerojet-General Corp., Sacramento). Acta Met., 13: 917-23(Aug. 1965).

Dislocation interstitial interactions were investigated in zone-melted single crystal tungsten by means of internal friction measurements. A Marx piezoelectric composite oscillator resonating at 50 kc/s was used to measure the log decrement as a function of time, temperature, and strain amplitude. Measurements on slightly cold worked single crystal tungsten showed that at temperatures above ~300°C the amplitude independent damping decreased with time and the strain amplitude necessary for breakaway increased. These effects were explained in terms of the diffusion of interstitial impurities, according to the $t^{\frac{1}{3}}$ law of Cottrell and Bilby, to the dislocation lines pinning them and rendering them immobile. An activation energy for the process was found to be 47,000 ± 5,000 cal/mole. The interstitial was not definitely identified, however, evidence tended to indicate interstitial carbon as the pinning agent. (auth)

37071 THE ACTIVITY OF OXYGEN IN LIQUID IRON–MOLYBDENUM AND IRON–TUNGSTEN ALLOYS. Tankins, E. S.; Thomas, M. K.; Erthal, J. F.; Williams, F. S. Am. Soc. Metals, Trans. Quant., 58: 245-52(1965).

Thermodynamic properties of dilute solutions of oxygen in Fe–Mo and Fe–W systems were studied by means of the hydrogen-water vapor equilibrium. The reaction, $H_2(g) + O(soln) = H_2O(g)$, was studied for which an equilibrium ratio can be written: $K = (P_{H_2O}/P_{H_2}[\%O])$, where P_{H_2O} and P_{H_2} are the partial pressures of water vapor and hydrogen and %O is the amount of dissolved oxygen in wt %. Equations are presented, which show the variation of the equilibrium constants as a function of composition and temperature for the Fe–W and Fe–Mo alloys. Equations are also presented, which show the variation of the standard free energies of solution of oxygen as a function of temperature for the 80Fe–20W and the 80Fe–20 Mo alloys. The interaction parameters for this system are also reported. (auth)

37072 LIQUIDUS CURVES OF NINETEEN DILUTE BINARY ALLOYS OF BISMUTH. Weeks, John R. Am. Soc. Metals, Trans. Quant., 58: 302-21(1965).

The liquidus curves of Be, Mg, Ca, Al, Si, Yb, Lu, Ti, Hf, V, Nb, Ta, W, Mn, Re, Co, Os, Ir, and Pt with Bi were measured by a sampling and chemical analysis technique. These data and previously published liquidus curves with Bi were examined for trends, which might be correlated with properties of the solutes. Attempts to correlate the thermodynamic properties of the systems as calculated from the liquidus curves with size effects or solute electronegativities were not successful. The cohesive energy of the solid played an important role in determining the position of the liquidus, both when intermetallic compounds and pure solid metals were in equilibrium with the melt. (auth)

37073 THE TERNARY ALLOY SYSTEM TUNGSTEN–RHENIUM–HAFNIUM. Taylor, A.; Doyle, N. J. (Westinghouse Research Labs., Pittsburgh). Am. Soc. Metals, Trans. Quant., 58: 341-52(1965).

The ternary system W–Re–Hf was surveyed using a combination of thermal, micrographic, and x-ray techniques. The phase fields were found to be extensions of those present in the constituent binary systems and no new ternary intermediate phases were discovered. At 1700°C, the α-W primary solid solution could extend as far as 6 at. % Hf and 29 at. % Re along the binary edges, and stretched to 74W–23Re–3Hf within the ternary triangle. The σ phase, which extended from about 43 to 65 at. % Re about the W–Re edge, took, at most, about 2 at. % Hf into solution at 1700°C. On the other hand, the narrow χ phases based on WRe_3 and $HfRe_7$, respectively, and which have the α-Mn structure, linked together and broadened into the ternary triangle, reaching as far as 40W–35Re–25Hf. Above 2125°C, the χ-phase decomposed peritectoidally to form hcp α-Re primary solid solution + σ phase. A Laves phase ϵ_4, which is of the hexagonal C12–$MgZn_2$-type and which is based on Re_2Hf, stretched across the ternary composition triangle until it almost reached η-W_2Hf, which has the $MgCu_2$–C15 Laves-type structure. The ϵ_4-$(Re,W)_2Hf$ phase was succeeded by a narrow phase ϕ based on ReHf, the structure of which is probably tetragonal. The Hf corner of the system consisted essentially of a solid solution of W and Re in bcc β-Hf which was capable, at low alloying contents, of transforming martensitically to hcp α-Hf. The system, as a whole, closely resembled the ternary system Mo–Re–Hf. (auth)

37074 URANIUM AS AN ALLOYING ELEMENT IN A POLYPHASE TITANIUM ALLOY. Ayvazian, Arthur M.; Colton, Robert M. (Army Materials Research Agency, Watertown, Mass.). Am. Soc. Metals, Trans. Quart., 58: 411-15(1965).

The effects of 0.25, 0.5, and 1.0% U on the titanium alloy, Ti–6Al–6V–2Sn–4Zr, were studied. Tensile strength, yield strength, per cent elongation, and per cent reduction of area were obtained from all tests. The lowest forging temperature, 1570°F, appeared to be the best of the working temperatures employed with respect to producing the optimum combination of mechanical properties for practically all the reported results. (M.C.G.)

37075 THE INFLUENCE OF RATE OF LOADING AND TEMPERATURE ON THE TENSILE PROPERTIES OF NORMAL α URANIUM. Loretan, P. A. (Babcock and Wilcox Co., Alliance, Ohio); Murphy, Glenn. Am. Soc. Testing Mater., Proc., 64: 734-46([1964]). (IS-785).

Forty tension tests were carried out on normal alpha-uranium to determine the influence of the rate of loading and temperature on its tensile properties. These tests were conducted at eleven different temperatures in the temperature range from 25 to 600°C for three constant loading rates (0.0017, 0.0130, and 0.0400 min^{-1}). The properties considered were tensile strength, per cent elongation (in 1.5-in. gage length), per cent reduction in area, yield strength, and modulus of elasticity. All of these properties were more strongly affected by a change in temperature than they were by a change in rate of loading. Graphs showing data for each of the five properties versus temperature and also as a function of rate of loading are presented to indicate specific effects. (auth)

37076 OPTICAL PROPERTIES OF BERYLLIUM IN THE ULTRAVIOLET FROM ELECTRON ENERGY ABSORPTION. LaVilla, R. E.; Mendlowitz, H. (National Bureau of Standards, Washington, D. C.). Appl. Opt., 4: 955-60(Aug. 1965).

A method for obtaining the optical constants of beryllium in the far ultraviolet based upon electron energy-loss experiments is described. This method correlates the electron interaction with the target material to the optical properties of the material. The n and k values and the reflectivity are presented for photon energies in the range $12 \leq E \leq 28$ ev. The n and k values are given and are checked for self-consistency by means of the Kronig-Kramers dispersion relations. The optical data have fitted by a two-parameter Drude model with a plasma energy of $\hbar\omega_p = 18.4$ ev and a relaxation time of 1.4×10^{-15} sec. (auth)

37077 ANALYSIS OF THIN FILMS OF TANTALUM REACTIVELY SPUTTERED IN NITROGEN ATMOSPHERE. Buvinger, E. A. (Air Force Avionics Lab., Wright-Patterson AFB, Ohio). Appl. Phys. Letters, 7: 14-15 (July 1, 1965).

Thin films of tantalum reactively sputtered in a nitrogen atmosphere were examined by electron diffraction. Evidence was noted that the tantalum nitride structure in the films is dependent, to some extent, on the sputtering voltage. Two previously unreported tantalum nitride structures were observed. (D.C.W.)

37078 STUDIES OF BERYLLIUM MECHANICAL PROPERTIES. Davidenkov, N. N.; Sidorov, B. A.; Shestopalov, L. M.; Mironov, N. F.; Bogorad, N. M.; Izhvanov, L. A.; Kostogarov, S. B. At. Energ. (USSR), 18: 608-16(June 1965).

Effects of the method of preparation on the mechanical properties of beryllium were tested with beryllium metal specimens prepared by magnesium thermal reduction of beryllium fluorides, distillation in a vacuum, and beryllium chloride electrolysis. Compact beryllium specimens prepared by metal-ceramic method from 500 μ and 50 μ (the latter was prepared only by distillations and magnesium thermol methods) fine dispersion powder were tested for ductility at 20, 200, 350, 425, 500, 600, 700, 800, 900, and 1000°C and for compression at 20° and maximum plasticity point of the material. The results showed that the highest plasticity and strength was found with specimens prepared by hot compression and extrusion of fine dispersion (50 μ) powder of distilled metal. A somewhat lower plasticity was found with metal ceramic specimens of larger grain (500 μ) powders of distilled or chloride electrolytic method. Treatment by extrusion improved all mechanical properties of beryllium. (R.V.J.)

37079 THERMOELECTRICAL PROPERTIES OF POLYCRYSTALLINE URANIUM. Tsvetaev, A. A.; Golovanov, Yu. N.; Chuzhko, R. K.; Kirillov, I. V. At. Energ. (USSR), 18: 642-4(June 1965).

The absolute differential thermoelectric properties (ϵ) and the Thompson emf for metals (σ) were studied as functions of temperature for uranium of various purity. Specimens of (99.83 and 99.98%) pure uranium wires 1.5 mm in diameter, ~50 mm long with two welded thermocouples (Pt–PtRh) at its ends were heated in argon at a rate of ~5°C/min. The differential emf was measured at 20°C intervals. Calculated curves for magnitudes of $\epsilon U = f(T)$ for various specimens are constructed and analyzed. (R.V.J.)

37080 INFLUENCE OF THE RATE OF CRYSTALLIZATION AND ANNEALING ON PLASTIC PROPERTIES OF HIGH-BORON STEEL. Grebennikov, R. V.; Chirkin, A. V. At. Energ. (USSR), 18: 642-4(June 1965).

The influence of casting and annealing methods on mechanical properties of high-boron steel (1.86 to 2.35% B, 19.9 to 20.7% Cr, 14.5 to 17.9% Ni, 0.03 to 0.05% C and 0.40 to 0.61% Si) was studied using 100 to 180 mm long and 60 mm wide ingots casted at 1450 to 1500°C and rolled at 1150 to 950°C into 6 to 1 mm thick sheets. The results showed that the subsequent high-temperature annealing improves the microstructure and ductility of the steel. (R.V.J.)

37081 SOME INTERMETALLIC COMPOUNDS OF EUROPIUM WITH ZINC, CADMIUM, AND MERCURY. Iandelli, Aldo; Palenzona, Andrea. Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat. (8), 37: 165-8(Sept.–Oct. 1964). (In Italian)

Examinations were made of the intermetallic compounds of Eu with Zn, Cd, and Hg and of Ca and Sr with Hg. The compounds were examined structurally and magnetically. The data obtained are tabulated. In this series of com-

pounds the behavior of Eu was that of an alkaline earth metal instead of that of a rare earth. (J.S.R.)

37082 THE MAGNETIC BEHAVIOR OF CERIUM IN INTERMETALLIC COMPOUNDS. IV. THE SYSTEMS Ce–Si, Ce–Ge, Ce–Sn, AND Ce–Pb. Ferro Ruggiero, Assunta; Olcese, Giorgio L. Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat. (8), 37: 169-74(Sept.-Oct. 1964). (In Italian)

Magnetic data on compounds in the systems Ce–Si, Ce–Ge, Ce–Sn, and Ce–Pb are reported. Magnetic susceptibility measurements were made between +200 and −200°C. The analytical data and the magnetic properties are tabulated. All the compounds of Ce with Si, Ge, and Sn followed the Curie-Weiss law, but only the intermediate phases of the Ce–Pb system obeyed the Curie-Weiss law. (J.S.R.)

37083 ELECTRON MICROSCOPE ANNEALING STUDY OF QUENCHED URANIUM DIOXIDE. Ashbee, K. H. G. (Berkeley Nuclear Labs., Glos, Eng.). Discussions Faraday Soc., No. 38, 309-16(1964).

Thin foils of uranium dioxide prepared from melts quickly cooled in an arc-furnace contain extensive stacking faults and defect tetrahedra. These foils were annealed during observation by transmission electron microscopy to produce hexagonal dislocation networks and the breaking-up of the tetrahedra. Analysis of the networks showed that they are two-dimensional and are comprised of dislocation lines lying in {211} planes. The dislocations were extended on planes containing their respect stacking fault displacement vectors, with the stacking fault planes at each node joined by stair-rod dislocations. The defect tetrahedra were crystallographically identical to those observed in quenched gold and NiCo. The annealing treatment caused these tetrahedra to break-up by the nucleation and glide of dislocations. The possible effect of dislocation networks and tetrahedra on reactor behavior is discussed. (auth)

37084 THERMAL CONDUCTIVITY OF SCANDIUM AND YTTRIUM AT LOW TEMPERATURES. Aliev, N. G.; Volkenshtein, N. V. Fiz. Metal. i Metalloved., 19: 793 (May 1965). (In Russian)

The thermal conductivity of small bars of Sc and Y 0.25-mm thick was found to increase linearly with temperature from 2 to 20°K. The results showed that the thermal conductivity increases from 0.004 at 2°K to about 0.055 watts/cm deg at 20°K for Y, and from 0.007 at 2°K to 0.080 watts/cm deg at 20°K for Sc. The specific electrical resistances of Sc and Y at room temperature are 71×10^{-6} and 80×10^{-6} ohm-cm, respectively. The ratio of electrical resistances $R = \rho_{293°K}/\rho_{4.2°K}$ was found to be 9.59 for Sc and 7.3 for Y. This ratio attains a value as high as 10^4 for very pure metals. The Lorentz numbers for Sc and Y were found to be 2.96×10^{-8} and 3.00×10^{-8} watt-ohm/deg^2, respectively, which were greater than the theoretical value of 2.45×10^{-8} watt-ohm/deg^2. It was concluded that there is a noticeable phonon lattice contribution to the thermal conductivity in addition to the electronic part of the thermal conductivity. (TTT)

37085 DIFFUSION OF RADIOISOTOPES IN GLASS AND MELTED BASALT. Ralkova, J. (Inst. of Nuclear Research, Rez, Czechoslovakia). Glass Technol., 6: 40-5 (Apr. 1965).

As a method for disposal and storage of high-level radioactive wastes, their incorporation into melted silicates or glasses was investigated. These materials are resistant to the influence of water, carbon dioxide, and oxygen at normal and moderately high temperatures, and the manufactured blocks are firm enough to permit safe transportation. The procedure consists in mixing finely crushed glass or rock with the waste solution, preliminary drying, then heating to the melting temperature. For safe handling, foaming, frothing, and bloating must be kept to a minimum. Of several materials investigated, easily melted glasses, and especially basalts, which had been previously melted, showed the best properties. To ensure absolute safety in the final storage of the blocks containing high-level radioactive wastes, the rates at which the incorporated ions move through the solid were studied. A cheap low-melting glass and a basalt (from Tesetice) were used to follow the diffusion of cesium and strontium in these materials because ^{137}Cs and ^{90}Sr are among the most dangerous constituents in the fission products remaining after reprocessing irradiated uranium. In glass in the temperature range of 300–600°C the diffusion coefficients (D) of the isotopes were found to be of the order of 10^{-13} to 10^{-11} cm^2/sec and in melted basalt between 440 and 850°C, 10^{-14} to 10^{-11} cm^2/sec. If the temperature of the basalt blocks does not exceed 600°C by accumulation of decay heat, it may be assumed that the diffusion coefficients of Cs and Sr will not exceed the value of 10^{-15} cm^2/sec which is the upper limit for the safe storage of high-level radioactive wastes. (TCO)

37086 MAGNETORESISTANCE IN SINGLE CRYSTALS OF GRAPHITE. Bhattacharya, R. (Indian Assn. for the Cultivation of Science, Calcutta). Indian J. Phys., 39: 53-64(Feb. 1965).

Transverse and longitudinal magnetoresistance in single crystals of graphite were studied at room temperature for currents both along and perpendicular to the basal plane. The effect of orientation of the magnetic field with respect to the direction of current as well as of the crystallographic axis were also studied. It was observed that for both transverse and longitudinal cases with currents along or perpendicular to the basal plane, maximum magnetoresistance is obtained only when the magnetic field is parallel to the hexagonal axis. Magnetoresistance was found to deviate from a H^2 (H being the magnetic field strength) law of magnetic-field variation down to the minimum field available for this investigation, namely about 350 oersteds. (auth)

37087 THE PHASE EQUILIBRIA AND CRYSTAL CHEMISTRY OF THE RARE EARTH-GROUP VI SYSTEMS. IV. LANTHANUM–TELLURIUM. Ramsey, T. H.; Steinfink, H.; Weiss, E. J. (Univ. of Texas, Austin). Inorg. Chem., 4: 1154-7(Aug. 1965).

The phases occurring in the lanthanum–tellurium system were LaTe, fcc, a = 6.436 Å, mp 1720°C; a solid solution series La_3Te_4–La_2Te_3, with a Th_3P_4-type structure, cubic lattice constants for the two end members of a = 9.628 and 9.619 Å, respectively and melting points at 1515 and 1485°C; a solid solution series $LaTe_{2.0}$–$LaTe_{1.7}$ with a tetragonal unit cell for $LaTe_{2.0}$ of a = 4.506 and c = 9.13 Å, and the melting point 1450°C; and finally the phase $LaTe_3$, orthorhombic, with a pseudo-tetragonal cell a = b = 4.41 Å, c = 26.1 Å, which melted incongruently at 835°C. (auth)

37088 INITIAL YIELDING AND FRACTURE IN NOTCHED SHEET MOLYBDENUM. Ault, R. T.; Spretnak, J. W. Intern. J. Mech. Sci., 7: 87-102(Feb. 1965).

Initial yielding and fracture initiation behavior of wrought stress relieved and recrystallized Mo was investigated at 20°C. The effects of notch severity and grain size on the nature of plastic flow in notched sheet tensile specimens were investigated with photoelastic coatings. The nature of fracture initiation in notched sheet tensile specimens was studied through the use of prepolished and etched tandem notch specimens. Griffith-Orowan theory for crack propagation and the Cottrell criterion for crack initiation were used to calculate the effective surface energies for crack propagation and initiation. (Rev. Metal Lit., Vol. 22, (June 1965))

37089 THE INFLUENCE OF RARE EARTH METALS ON THE CONSTRUCTION STEEL ANNEALING DUCTILITY. Zav'yalov, A. S.; Sandomirskii, M. M. Izv. Akad. Nauk SSSR, Metal., No. 1, 113-18(Jan.-Feb. 1965). (In Russian)

The rare earth elements, especially in concentrations of 0.10 to 0.15%, decrease the susceptability of construction steels both to nonreversible and to reversible anneal brittleness and displace the brittleness threshold toward lower temperatures both after fast and after slow cooling. The rare earth elements displace the temperature interval for the development of nonreversible ductile brittleness

toward higher temperatures and weaken its development. (tr-auth)

37090 TERNARY PHASE DIAGRAM OF W–Mo–Zr ALLOY. Zakharov, A. M.; Savitskii, E. M. Izv. Akad. Nauk SSSR, Metal., No. 1, 151-9(Jan.-Feb. 1965). (In Russian)

By means of microscopic and x-ray phase analyses the melting point and microhardness were determined for polythermal cross sections of the ternary system W–Mo–Zr with a W:Mo ratio in the alloys of 4:1, 1:1, and 1:4. Projections of the system on the plane of a concentration triangle and the isothermal cross sections at 1800, 1500, and 1000°C were constructed. The ternary system W–Mo–Zr is characterized by a continuous transition of the three-phase peritectic $L + \alpha \rightharpoonup W_2Zr$ and eutectic $L \rightharpoonup \beta + W_2Zr$ transformations occurring in the binary system W–Zr at 2260 and 1640°C respectively, and into the peritectic $L + \alpha \rightharpoonup Mo_2Zr$ and eutectic $L \rightharpoonup \beta + Mo_2Zr$ transformations occurring in the binary system Mo–Zr at 1890 and 1570°C, respectively, where the α-solid solution is based on tungsten or molybdenum and the β-solid solution is based on β-Zr. A continuous series of solid solutions of $(W, Mo)_2Zr$ are formed between the chemical compounds W_2Zr and Mo_2Zr in the ternary system W–Mo–Zr according to the cross section $W_2Zr–Mo_2Zr$; the three-phase peritectic and eutectic transformations occurring in the ternary alloys in the temperature ranges 2260 to 1890 and 1640 to 1570°C, respectively, can be written as $L + \alpha \rightharpoonup (W, Mo)_2Zr$ and $L \rightharpoonup \beta + (W, Mo)_2Zr$. The combined solubility of W and Mo in Zr and, conversely, Zr in W and Mo in the solid state decreases with a reduction of temperature; for example, the solubility of W and Mo in β-Zr along a section where the ratio of W:Mo = 1:1 at 1500°C amounts to about 7.5 wt.%, but at 1000°C it is less than 5%; the solubility of Zr in W and Mo at that same section at 1800°C exceeds 3.5 to 4%, but at 1000°C it amounts less than 2.5%. (CFSTI)

37091 PREPARATION AND PROPERTIES OF SOLID SOLUTIONS OF Ti, Zr, Nb, Ta CARBIDES WITH Hf CARBIDES. Samsonov, G. V.; Paderno, V. N. Izv. Akad. Nauk SSSR, Metal., No. 1, 180-8(Jan.-Feb. 1965). (In Russian)

A series of binary TiC–HfC and ZrC–HfC systems containing 20 to 80 mol% HfC, and binary NbC–HfC and TaC–HfC systems containing 11 to 67 mol% HfC were synthesized by combined reduction with carbon of the mixtures of oxides of corresponding metals at 1000°C and simultaneous compacting of the reduction products under a pressure of 180 kg/cm², followed by sintering at 2200°C. The synthesis required about 30 min; the finished products had a 25% porosity. Subsequent powdering, followed by compacting under a pressure of 300 kg/cm² and sintering at 2500 to 2700°C for 5 min produced dense systems with a porosity of 5 to 7%. The investigated carbides formed continuous series of solid solutions. Changes in the lattice constants of HfC–ZrC systems indicated a stronger atom interaction in the solid-solution systems, compared with individual carbides. The thermal expansion coefficient in HfC–NbC and HfC–ZrC system was lower than in individual carbides. The expansion coefficient in the HfC–TaC system was particularly small, and the melting temperature correspondingly high. An 80 mol% TaC–20 mol% HfC system had a melting temperature of 4050 ± 50°C. The microhardness of TaC–HfC and NbC–HfC systems approached the microhardness of HfC with additions of up to 10% HfC and remained practically constant with further additions. Correlation of the data obtained showed that the changes in the physical properties of the solid solutions of carbides are determined by the relationship between the acceptor capacity of the metal atoms and the probability of forming stable electron configurations of the d^5 type. (CFSTI)

37092 INVESTIGATION OF HOT BRITTLENESS OF MAGNESIUM–ZINC–ZIRCONIUM ALLOYS. Novik, F. S.; Novikov, I. I.; Tikhonova, V. V.; Korolkov, G. A. Izv. Vysshikh Uchebn. Zavedenii, Tsvetn. Met., No. 6, 104-8 (1964). (In Russian)

The effects of composition and structure on crystallization cracking resistance of Mg alloys were investigated, using the temperature relationship of relative elongation and linear shrinkage (plasticity reserve) in solid-liquid state as a measure of resistance. Influence of cooling rate on plasticity in solid-liquid state and effect of Zn content on hot brittleness were also studied. (Rev. Metal Lit., Vol. 22, (June 1965))

37093 COMBUSTIBILITY OF ZIRCONIUM–TITANIUM ALLOYS. Ioffe, V. G. Izv. Vysshikh Uchebn. Zavedenii, Tsvetn. Met., No. 6, 125-30(1965). (In Russian)

Determination was made of the combustibility temperatures of spontaneously combustible Zr-Ti, Zr-Si, Ti-Al, Ti-Mn, and Ti-Si alloys and a combustibility diagram for the Zr-Ti system was constructed. An approximate expression for the relationship of temperature of a spontaneously combustible alloy to its composition was developed and it was established that the Zr-Ti, Ti-Al, Ti-Mn systems satisfactorily conform to this relationship. Combustibility of Zr-Si and Ti-Si alloys strongly deviates from this relationship, which is probably due to the formation of refractory silicides. (Rev. Metal Lit., Vol. 22, (June 1965))

37094 ELECTRICAL CONDUCTIVITY IN THE ZrO_2-RICH REGION OF SEVERAL M_2O_3–ZrO_2 SYSTEMS. Strickler, D. W.; Carlson, W. G. (Westinghouse Research Labs., Pittsburgh). J. Am. Ceram. Soc., 48: 286-9(June 21, 1965).

The electrical conductivity of $M_2O_3–ZrO_2$ compositions containing 6 to 24 mole % M_2O_3, where M represents La, Sm, Y, Yb, or Sc, was examined. Only Sm_2O_3, Y_2O_3, and Yb_2O_3 formed cubic solid solutions with ZrO_2 over most of this substitutional range. Se_2O_3 formed a wide cubic solid solution region with ZrO_2 at temperatures above 1300°C whereas the cubic solid solution region at room temperature was narrow (6 to 8 mole % Sc_2O_3). La_2O_3 additions to ZrO_2 produced no fluorite-type cubic solid solutions within the compositional range investigated. Generally, the electrical conductivity of these cubic solid solutions increased as the size of the substituted cation decreased and the electrical conductivity for each binary system attained a maximum at about 10 to 12 mole % M_2O_3. (auth)

37095 PROOF-TESTING GRAPHITE AND ITS DESIGN IMPLICATIONS. Daily, J. W.; Hjelm, L. N. (IIT Research Inst., Chicago). J. Am. Ceram. Soc., 48: 338-41(July 1965).

The influence of proof-testing on the behavior of CFW graphite is describing and the improvements in the strength associated with a given probability of failure were established. Damage induced in the graphite by the proof-test process was examined in more detail by conducting low-cycle fatigue tests. Fatigue deterioration of the strength of the graphite was cumulative and the number of cycles of load significantly influenced the probability of failure. A modified Gaussian distribution function accounted for the influence of both the stress and the number of load cycles on the probability of failure. (auth)

37096 MECHANICAL FAILURE PHENOMENA IN PYROLYTIC GRAPHITE AT ROOM TEMPERATURE. Berry, J. M.; Gebhardt, J. J. (General Electric Co., Valley Forge, Penna.). J. Am. Ceram. Soc., 48: 350-6(July 1965).

The mechanical behavior of pyrolytic graphite was investigated, to develop an understanding of the phenomena of failure and to apply it to the interpretation of mechanical properties data and to explore techniques for increasing room temperature strength. Pyrolytic graphite is exceedingly anisotropic and brittle. The conditions of deposition determine the degree of anisotropy and this, in turn, has a marked effect on the relations among specimen-test configuration, nominal strength, and fracture mode. The "notch sensitivity" is orientation dependent and thus related to the degree of anistropy. The mechanical test results and studies of the fracture modes suggested that results from testing conventional laboratory specimens

are not necessarily representative of those which would be obtained by testing free-standing structures. (auth)

37097 WORK FUNCTION MEASUREMENTS OF NICKEL, MOLYBDENUM, AND TUNGSTEN IN A CESIUM–HYDROGEN ATMOSPHERE. Rump, B. S.; Gehman, B. L. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Appl. Phys., 36: 2347-52(Aug. 1965).

The addition of a second component to the cesium gas phase of a ther nionic generator could increase its efficiency by reducing the work functions of the electrodes. The different possible additives were screened; and hydrogen, since it appeared to be the most promising, was chosen for further study. The work function reduction of cesium-covered nickel, molybdenum, and tungsten due to the presence of H_2 in the gas phase ranges from 0 to 0.5 ev. An equilibrium condition can be established between the surface and the gas phase to make the low work function surface stable at elevated temperatures. (auth)

37098 WORK FUNCTION OF CESIUM-COVERED NICKEL—THERMIONIC AND PHOTOELECTRIC MEASURING TECHNIQUES. Rump, B. S.; Gehman, B. L. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Appl. Phys., 36: 2352-7(Aug. 1965).

The work function of cesium-covered nickel was measured by the thermionic and photoelectric methods. A modulated light beam technique allowed the measurement of the photoelectric emission currents in the presence of thermionic currents that were 10^6 times larger. The minimum work function of cesium-covered nickel was determined to be 1.42 ± 0.05 ev by the thermionic method at a nickel temperature of 530°K and a cesium reservoir temperature of 333°K. The results obtained by the photoelectric method were, on the average, 0.05 eV lower than the values determined by the thermionic method. The discrepancy is expected because of the bias introduced to both methods by local variations in work function. The agreement of the data obtained by the two methods indicates that the Richardson constant is close to the assumed value of 120 amp/$cm^2 \cdot deg^2$. The work was undertaken as a first step toward the improvement of cesium-filled thermionic generators by lowering the collector work function. (auth)

37099 FIELD-EVAPORATION END FORM OF TANTALUM. Nakamura, Shogo; Mueller, Erwin W. (Pennsylvania State Univ., University Park). J. Appl. Phys., 36: 2535-9(Aug. 1965).

A field-evaporation end form depends in a complicated way upon many factors. The end form of a pure and nearly perfect metal crystal as obtained under various conditions must be established experimentally to permit proper interpretation of field-ion micrographs of general specimens of that metal. The end form of tantalum, distinctly different from other bcc metals much as tungsten, molybdenum, and iron, is shown in its dependence on temperature, hydrogen promotion, and field-stress-induced slip. Low-coordination atom sites stabilized by polarization occur in specific crystallographic regions. (auth)

37100 ELECTRON EMISSION FROM SOLIDIFYING URANIUM SURFACES. Sahm, P. R. (RCA Labs., Princeton, N. J.). J. Appl. Phys., 36: 2596-8(Aug. 1965).

Thermionic emission from liquid, solidifying, and solid uranium was observed as a function of temperature in a demountable diode. An emission peak was observed during solidification, but the peak was never reproduced below a background pressure of 1×10^{-7} Torr. It was concluded that the diminishing peak effect at the melting point reflects an independent reaction, specifically occurring at the melting point. (D.C.W.)

37101 THE CONDENSED SYSTEM $LiF-NaF-ZrF_4$—PHASE EQUILIBRIA AND CRYSTALLOGRAPHIC DATA. Thoma, R. E.; Insley, H.; Friedman, H. A.; Hebert, G. M. (Oak Ridge National Lab., Tenn.). J. Chem. Eng. Data, 10: 219-30(July 1965).

Equilibrium phase diagrams of the ternary system $LiF-NaF-ZrF_4$ and the limiting binary system $LiF-ZrF_4$ are presented. Equilibria among the condensed phases in the systems were established through the temperature interval from the liquidus to approximately 400°C. Composition-temperature relationships were established for the 4 invariant reactions of the $LiF-ZrF_4$ system and the 9 invariant reactions of the $LiF-NaF-ZrF_4$ system. Three equilibrium compounds were observed to form from LiF and ZrF_4—namely, $3LiF \cdot ZrF_4$, $2LiF \cdot ZrF_4$, and $3LiF \cdot 4ZrF_4$. A single ternary compound, $LiF \cdot NaF \cdot 4ZrF_4$, was isolated from crystallized salt mixtures. Complex solid solutions are formed between $LiF-ZrF_4$ and $NaF-ZrF_4$ compounds. Solution behavior is attributed principally to substitutional mechanisms. Representative optical and x-ray diffraction data are presented for all solid phases encountered in the ternary system. (auth)

37102 DIFFUSION COEFFICIENT OF FISSION GAS IN URANIUM DIOXIDE POWDER FORMED BY CARBON DIOXIDE OXIDATION OF URANIUM. STUDY ON THE BEHAVIOR OF A PUNCTURED FUEL ELEMENT FOR CALDER-HALL TYPE REACTOR. [PART] 4. Taketani, Kiyoaki; Ikawa, Katsuichi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 212-16(June 1965).

In connection with a program to study the behavior of punctured fuel elements for the Tokai Atomic Power Reactor, the diffusion coefficient of fission gas in uranium oxide powder formed by CO_2 oxidation of U was determined by post-irradiation experiment, in which the fractional release of fission gas during isothermal heating of the powder was measured. The U was oxidized at 600 and 700°C, and in both cases the O/U ratio of the oxides, measured gravimetrically, was 2.0. The diffusion coefficients in the oxide powder formed by oxidation at 600°C were found to be 1.4×10^{-20}, 1.3×10^{-19}, 1.1×10^{-18} and 1.0×10^{-17} cm^2sec^{-1}, respectively at 450, 550, 650, and 750°C, and in the oxide powder formed at 700°C, 7.4×10^{-19} and $3.6 \times 10^{-16}cm^2sec^{-1}$ at 600 and 700°C, respectively. Activation energies calculated for the two oxide powders were comparatively low. (auth)

37103 MEASUREMENT OF FINE PORES IN SINTERED UO_2 BY KRYPTON ADSORPTION. Ikawa, Katsuichi; Taketani, Kiyoaki. J. Nucl. Sci. Technol. (Tokyo), 2: 237-8(June 1965).

Since pore size as well as surface area might be a factor affecting fission gas release from sintered uranium oxide, an attempt is made to measure this pore size. Krypton adsorption, at liquid nitrogen temperature, was applied to the size measurement of fine pores in a highly sintered UO_2 pellet. The hysteresis loop on the isotherm indicated the presence of extremely fine pores, since this effect may be due to the difficulty of the absorbate molecules in diffusing through the fine pores. The contribution of the fine pores to the total surface area was found to be about 1%, the average pore diameter being 21 Å units. This pore size is too small to be measured by the present methods. (J.F.P.)

37104 TITANIUM, ZIRCONIUM, AND YTTRIUM HYDRIDES AS SPACE SHIELDING MATERIALS. Van Houten, Robert; Baxter, W. G. (General Electric Co., Cincinnati). J. Spacecraft Rockets, 2: 469-72(May–June 1965).

Hydrides of Ti, Y, and Zr were tested as shield materials for space nuclear power plants. Fabrication techniques and engineering design data are also included. Titanium hydride has the highest useful H content per unit volume (to 0.16 g H/cm^3) of any known, thermally stable (300°C and above), massive solid material. Experiments were conducted on arc-cast buttons of Ti and Ti alloys to determine the amount of metallurgical processing required to refine the normal cast structure and improve the hydriding characteristics in order to allow high N_H (7.0–8.9) massive hydride bodies to be obtained. Modulus-of-rupture results indicated: outstanding strength and ductility at temperatures above 350°C; and capability of retaining useful engineering properties after prolonged exposure under normal atmospheric operation conditions. The equilibrium hydrogen pressures of yttrium hydride at high temperatures are significantly lower than those of any

other known hydride and offer the promise of at least a 200°C higher allowable operating temperature. Chromium addition increased the mechanical stability of the hydrided yttrium, and chrome cladding provided oxidation resistance. Specimens were tested in air for 10,000 to 11,000 hr at temperatures of 950-1040°C, being subjected to numerous, relatively severe thermal cycles during the course of the test. No core cracks were apparent in the first 5000-hr test period. Limited core cracking was observed in all of the specimens after 10,000 hr. Three high-temperature, air-cooled reactor tests were conducted. The longest was in air at 900°C for 5100 hr for an estimated thermal neutron exposure of 1.3×10^{20} nvt. No evidence of distortion, dimensional or weight instability, or clad blisters was found. Zirconium hydride density (5.6 g/cm^3) is the highest for the metal hydride materials tested and it has an 800°C temperature limitation. The possible future uses of these three metal hydrides as nuclear shield and moderator materials in advanced power plants are discussed. (TCO)

37105 EXCEPTIONAL METALS. Mater. Protect., 4: 7-8(Jan. 1965).

Some new processes and applications of metals with exceptional corrosion resistance are briefly reviewed, a survey was made of references published as abstracts pertaining to these metals. In the past three years there was a total of 2593 abstract references. Largest numbers of abstracts were of articles on Be, Nb, Mo, Ta, Ti, Zr. At least part of the increased use of these exceptional metals for corrosion resistant applications is due to improved and more economical means of fabrication. Projected uses are mentioned. (TCO)

37106 WORK HARDENING AND RECOVERY PHENOMENA IN ZIRCONIUM. Desalvo, A.; Gondi, P.; Missiroli, G. F.; Zignani, F. (Universita, Bologna). Met. Ital., 57: 177-86(May 1965). (In Italian)

A preliminary analysis of the work hardening and recovery phenomena in zirconium was carried out through electrical resistivity measurements and x-ray and electron microscope observations. Work hardening proceeds through two stages: in the first, all the physical properties observed, resistivity, line breadth, and dislocation density, varied considerably, while in the second only electrical resistivity varied. This showed that as deformation increases, the defects introduced are mostly point defects. Recovery, too, proceeded through two stages: the first, characterized by a 30 kcal/mol activation energy, was attributed to migration and annihilation of vacancies essentially on dislocations. The second, coinciding with recrystallization was characterized, in its initial phase, by a 52 kcal/mol activation energy, in agreement with the self-diffusion value found by Lyashenko et al. Finally, from the electron microscopical determination of dislocation density for low deformations a contribution of dislocations to resistivity of the order of magnitude of 10^{-17} Ω cm^3 was calculated in agreement with recent data of other authors. (auth)

37107 PHASES WITH FILLED Ti_2Ni TYPE. Jeitschko, W.; Holleck, H.; Nowotny, H.; Benesovsky, F. (Universitaet, Vienna). Monatsh. Chem., 95: 1004-6(1964). (In German)

Metalloid-stabilized phases of the type Ti_2Ni (E 9_3) prepared in the proportion listed (transition:metal : meta metal : C) exhibit lattice parameters as given, with observation on amount of E 9_3 type phase produced: Ti_2ZnC_x, 3:1:1, 11.56_4, little E 9_3; Ti_2ZnC_x, 5:3:1, 11.55_3, much E 9_3; Ti_2ZnN_x, 3:1:1, 11.50_1, little; Ti_2ZnN_x, 5:3:1, 11.49_8, much; Zr_2RuX_x, 2:1:x, 12.30, -; Zr_2ZnC_x, 2:1:1, 12.16_8, generally homogeneous; Zr_2ZnC_x, 5:3:1, 12.07_2, less than previous; Zr_2ZnN_x, 2:1:1, 12.13_1, generally homogeneous; Zr_2ZnN_x, 5:3:1, 12.07_3, less than previous; Hf_2ZnC_x, 2:1:1, 12.04_4, less homogeneous than following; Hf_2ZnC_x, 5:3:1, 11.95_7, generally homogeneous; Hf_2ZnN_x, 5:3:1, 11.96_8, generally homogeneous; Nb_2CoX_x, 2:1:x, 11.64,-; Nb_2NiX_x, 2:1:x, 11.61, -; Nb_2ZnC_x, 2:1:1, 11.74_8, generally E 9_3; Nb_2ZnN_x, 2:1:1, 11.54_7, E 9_3 & Nb(N,O). In several examples above X = (C, N, O). The line intensities depend greatly on arrangement and atomic size. Metal-X distances are given in Å as follows: Ti-C in Ti_2ZnC_x, 2.14; Ti-N in Ti_2ZnN_x, 2.13; Zr-C in Zr_2ZnC_x, 2.26; Zr-N in Zr_2ZnN_x, 2.25; Hf-C in Hf_2ZnC_x, 2.23; Hf-N in Hf_2ZnN_x, 2.22; Nb-C in Nb_2ZnC_x, 2.18; Nb-N in Nb_2ZnN_x, 2.15. The structure of these materials is discussed in terms of the Ti_4Cu_2O structure. (BBB)

37108 PHASES WITH Cu_3Au OR FILLED Cu_3Au TYPE (PEROVSKITE-CARBIDES). Jeitschko, W.; Nowotny, H.; Benesovsky, F. (Universitaet, Vienna). Monatsh. Chem., 95: 1040-3(1964). (In German)

The phases Ce_3In, Ce_3Tl, Ce_3Sn, and Ce_3Pb were prepared by sintering in sealed quartz ampoules between 600 and 850°C for 500 to 1000 hr. A large heat of reaction was noted in some cases. Ternary compounds were also prepared with C; all compounds had a metallic appearance, but had to be protected from air, particularly the ternary compounds. Mixtures corresponding to Y_3Tl and Y_3Pb and Y-Pb-C had a hexagonal closest packing, while Y-Tl-C had cubic closest packing with a = 4.88_9 Å. The latter had a companion phase of Y_3Tl, hexagonal packing. In the case of the Ce compounds the C-containing phases had a noticeably greater parameter, arising from the incorporation of a C atom into the Ce octahedron; the parameters (Å) were as follows: Ce_3In, 5.02_3; Ce_3InC_x, 5.10_3; Ce_3Tl, 5.01_1; Ce_3TlC_x, 5.09_6; Ce_3Sn, 4.92_9; Ce_3SnC_x, 5.10_1; Ce_3Pb, 4.96_4; Ce_3PbC_x, 5.11_2. This increase in cell volume by the incorporation of C is particularly noticeable by comparison of atomic volumes of Ce and its various alloys with the metals used. The compounds Ce_3Al, Ce_3In, and Ce_3Tl differ little in cellular dimension; the Sn and Pb compounds are smaller; a similar tendency was noted with AB phases of the CsCl type but the tendency is greater with alloys with greater atomic percent of rare earth metal. The compound Nb_3In has a β-W structure, is prepared in similar fashion, and has a = 5.277 Å. (BBB)

37109 PHASES WITH FILLED β-MANGANESE STRUCTURE. Jeitschko, W.; Nowotny, H.; Benesovsky, F. (Universitaet, Vienna). Monatsh. Chem., 95: 1212-18 (1964). (In German)

The nitrides V_3Zn_2N and V_3Ga_2N were prepared by sintering in sealed quartz ampoules 700 hr at 750-850°C; Nb_3Al_2N was prepared by hot pressing and homogenization. Lattice parameters (Å) for the β-Mn structure of these compounds and several carbides are reported as follows, together with the x-ray density (g/cm^3): V_3Zn_2N, 6.60_8, 6.85; V_3Ga_2N, 6.62_0, 7.01; Nb_3Al_2N, 7.03_4, 6.61; Nb_3Al_2C, 7.07_2-7.07_9, 6.49; Ta_3Al_2C, 7.03_9, 11.59; Mo_3Al_2C, 6.86_0-6.86_8, 7.24. In cases where two values are reported for the lattice parameter, the lower value refers to the Al-rich boundary, the higher to the Al-poor boundary. Tables of observed and calculated intensities for Debye-Scherrer patterns are given for V_3Zn_2N and Nb_3Al_2N. The intensity pattern of V_3Ga_2N corresponds to that of V_3Zn_2N. In the lattice each octahedral unit shares its vertices with six other units; the metalloid atom is at the center of the octahedron. In relation to the small Mn-Mn distance found in β-Mn, small internuclear distances are also found for the meta metal-meta metal; these range from 2.42 Å in the V compounds to 2.59 in Nb_3Al_2C. The partial lattice of meta metals is characterized by three nearest neighbors of the same atomic type; the lattice resembles the Si lattice in α-$ThSi_2$. The Al-Al-Al angle is 117°50′. The atomic volumes in these compounds are compared with those found for the binary compounds between the metals. (BBB)

37110 TRANSMISSION ELECTRON MICROSCOPIC STUDIES OF DEFORMED POLYCRYSTALLINE MOLYBDENUM AT A LOW TEMPERATURE. Yoshioka, Shozo; Nakayama, Yutaka; Takeda, Masaaki (Univ. of Osaka Prefecture, Sakai, Japan). Nippon Kinzoku Gakkaishi, 29: 211-16(1965). (In Japanese)

The distribution and behavior of dislocations in polycrystalline molybdenum after tensile deformation at -78°C were studied by means of transmission electron microscopy. In the early stage of plastic deformation, grain

boundaries played an important role as a dislocation source. It seemed that the sharp yield drop in polycrystalline molybdenum was a result of the rapid dislocation multiplication by the double cross slip mechanism. No piled-up groups of dislocations against the grain boundaries were observed at the lower yield point. The average dislocation density increased with the amount of strain. At −78°C from the lower yield point to about 5.5% strain, the tendency for the formation of dislocation tangles lessened and the distribution of dislocations seemed to be uniform, and beyond about 5.5% strain the formation of dislocation tangles seemed to become somewhat clearer. The distribution of dislocation loops appeared to be uniform. In the case of polycrystalline molybdenum having an average grain size 30 μ and strained by an initial strain rate 1.7×10^{-4} sec^{-1} at −78°C, the behavior of work-hardening is divided into two stages: one is the linear hardening stage and the other is the parabolic hardening one. (auth)

37111 THE ELECTRICAL AND THERMAL CONDUCTIVITY OF LIQUID CESIUM TO 1650°C AND THE CRITICAL POINT OF CESIUM. Hochman, Jack M.; Bonilla, Charles F. (Columbia Univ., New York). Nucl. Sci. Eng., 22: 434-42(1965).

The electric resistivity of high-purity liquid cesium was determined in a pressurized furnace from 600 to 3000°F (316 to 1649°C) by measurements of the electric resistance of a Ta-10%W alloy tube, both empty and filled with cesium. The resistivity found for the lower temperatures agrees moderately well with previously published results, the discrepancy decreasing at the highest temperatures. The thermal conductivity of liquid cesium was calculated from its resistivity using a Lorenz number of 2.3×10^{-8} $(V/deg\ K)^2$. By comparing the cesium data with a reduced resistivity vs reduced temperature curve for mercury, the critical temperature of cesium is found to be 3190°F (1754°C), with a corresponding critical pressure of 130.8 atm from an available vapor-pressure correlation. (auth)

37112 INTERACTION OF REFRACTORY COMPOUNDS WITH MOLTEN METALS. Yasinskaya, G. A. Ogneupory, No. 2, 20-3(1965). (In Russian)

Crucibles of TiC, ZrC, Cr_3C_2, Mo_2C, WC, TiB_2, ZrB_2, CrB_2, Mo_2B_5, W_2B_5, TiN, ZrN, BN, Si_3N, and $MoSi_2$ materials were prepared by powder metallurgy technique. Determination was made of chemical interaction, chemical activity, and the resulting phases of interaction (if any) of a crucible in contact with the molten metals in vacuum from 400 to about 1500°C. The following molten metals and their chemical interaction with materials of crucibles were investigated: Cu, Mg, Zn, Cd, Al, Si, Ti, Zr, Sn, Pb, V, Bi, Cr, Mn, Fe, Co, and Ni. From the results the tested crucible materials were classified into five groups with respect to their resistance to chemical interaction and their service life. (Rev. Metal Lit., Vol. 22, (June 1965))

37113 THE LANTHANUM–ALUMINIUM SYSTEM. Buschow, K. H. J. Philips Res. Rept., 20: 337-48(June 1965).

The lanthanum-aluminum system was found to contain six intermediate phases: La_3Al (hexagonal Mg_3Cd type), LaAl (orthorhombic CeAl type), $LaAl_2$ (cubic $MgCu_2$ type), $La_{0.88}Al_{2.12}$ (hexagonal AlB_2 type), $LaAl_3$ (hexagonal Mg_3Cd type), and $LaAl_4$ which is orthorhombic at room temperature but is transformed into a tetragonal modification ($BaAl_4$ type) on heating. By means of thermoanalytical data the phase diagram of the system was constructed. (auth)

37114 DISLOCATION MOBILITY IN FCC METALS BELOW 1°K. Alers, G. A.; Zimmerman, J. E. (Ford Motor Co., Dearborn, Mich.). Phys. Rev., 139: A414-18 (July 19, 1965).

Previous experiments have shown that the elastic moduli of pure fcc metals are lowered by the presence of mobile dislocation loops. The amount of this lowering is often called the modulus defect. Results of accurate modulus measurements from 20°K down to 0.1°K using liquid-helium and adiabatic-demagnetization techniques show that this modulus defect is temperature-dependent and decreases as the temperature approaches absolute zero. Thus the mobility of dislocations must be decreasing at these low temperatures with most of the decrease confined to temperatures below 1°K. In fact, the decrease is most rapid at 0.1°K. No attenuation changes were observed which could be directly associated with the modulus changes, thereby ruling out the possibility that the decreased mobility of dislocations arises from a thermally activated process with a unique but small activation energy. The present modulus measurements are in apparent disagreement with the often quoted statement that the elastic moduli must approach absolute zero with zero slope. However, the absolute zero of temperature has not been obtained, and there is no reason to expect that the observed dislocation effects should not ultimately approach zero with a zero slope at temperatures much below 0.1°K. (auth)

37115 ELECTRICAL BEHAVIOR OF PLUTONIUM–NEPTUNIUM ALLOYS. Olsen, Clayton E.; Elliott, R. O. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 139: A437-41(July 19, 1965). (LA-DC-6750)

The electrical behavior of a series of plutonium-neptunium solid-solution alloys was investigated between 1 and 300°K. The effect of alloying on residual resistivity is substantially different from that usually seen in solid-solution alloys. An interpretation is advanced for this behavior. (auth)

37116 MAGNETORESISTANCE AND MAGNETIC BREAKDOWN IN WHITE TIN. Young, R. C. (Ames Lab., Ames, Iowa). Phys. Rev. Letters, 15: 262-3(Aug. 9, 1965). (IS-1168).

A preliminary study to the magnetoresistance of single crystals of white tin (resistivity ratios $\rho_{300°K}/\rho_{4.2°K}$ of about 30,000) at 4.2°K and in magnetic fields up to 100 kG revealed structure in the anisotropy of the resistance not previously reported. It is shown that the free-electron model (A.V. Gold and M. G. Priestly, Phil. Mag., 5: 57 (1960)) for the Fermi surface of white tin appears to account for the observations if modifications due to magnetic breakdown are allowed. Resistance measurements were made by the conventional method using a superconducting solenoid. (J.F.P.)

37117 ROTATIONAL ANALYSIS OF THE A–X SYSTEM OF TELLURIUM MONOXIDE. Chandler, G. G.; Hurst, H. J.; Barrow, R. F. (Oxford Univ.). Proc. Phys. Soc. (London), 86: 105-15(July 1965).

A fairly complete rotational analysis was made of a number of bands of the main system A–X of TeO using two separated tellurium isotopes. A new vibrational analysis is proposed and is confirmed by the isotope effect. The structure of the bands indicates that Hund's case c applies to both states, so that the transition is better described as $A0^+ - X0^+$, $A1 - X1$, rather than $A\,^3\Sigma^- - X\,^3\Sigma^-$. Transitions $1 - 0^+$, $0^+ - 1$ have not been observed. The upper state is perturbed, and is also predissociated in $A0^+$ at $v = 9$. The dissociation energy D_0' is estimated to be about 90 kcal $mole^{-1}$. (auth)

37118 DIFFUSE MAGNETIC SCATTERING OF NEUTRONS FROM A METALLIC ANTIFERROMAGNET. Hicks, T. J. (Monash Univ., Victoria, Australia); Browne, J. D. Proc. Phys. Soc. (London), 86: 139-46(July 1965).

Diffuse magnetic scattering of neutrons is observed around the magnetic Bragg peaks and at the (100) position in fcc Mn-Pd alloys. Results for the alloy containing 15 at. % Pd, which has a Néel temperature of 347°k, are presented in detail. The diffuse scattering is discussed in terms of static short-range magnetic order, small particle size line broadening, and inelastic magnetic scattering. It is shown that the inelastic scattering model is consistent with the scattering observed. From the magnitude of the scattering an estimate is made of the "exchange energy." (auth)

37119 PHASE EQUILIBRIUM IN THE Zr–W–C SYSTEM. Kuz'ma, Yu. B.; Fedorov, T. F.; Shvets, E. A.

Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 2, 22-5 (1965). (In Russian)

Alloys of Zr–W–C of various concentrations were prepared by powder metallurgy. Helium arc melting of the produced powder compacts and annealing the cast specimens at 1500 and at 1950°C were investigated. X-ray and microscopic studies of the phase equilibrium were made at 1500°C. The following phases were identified: alpha-Zr, W, W_2C, omega phase with NaCl-type lattice, ZrC, WC, and ZrW_2 phase. No ternary phases were detected. (Rev. Metal Lit., Vol. 22, (June 1965))

37120 RELATIONSHIP BETWEEN THE HARDNESS AND STRENGTH CHARACTERISTICS OF TUNGSTEN AND MOLYBDENUM OVER A WIDE TEMPERATURE RANGE. Borisenko, V. A. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 2, 57-9(1965). (In Russian)

Formulas for calculation of the relationship between tensile strength and hardness of work-hardened W and Mo specimens are given. Graphs of experimental data on relationship between hardness and yield strength and hardness and tensile strength for the same metals at 1000 to about 2000°C are presented. (Rev. Metal Lit., Vol. 22, (June 1965))

37121 PREPARATION AND DETERMINATION OF SOME PROPERTIES OF ALLOYS OF ZIRCONIUM BORIDE WITH MOLYBDENUM DISILICIDE. Kuzenkova, M. A.; Kislyi, P. S. (Inst. of Problems in Metallography, Academy of Sciences, Ukrainian SSR). Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 6, 55-9(June 1965). (In Russian)

Alloys of zirconium boride with molybdenum disilicide were obtained. A microstructural and roentgenophase analysis showed that alloys with an addition of up to 15% of $MoSi_2$ are single-phase. The melting point and microhardness of the alloys were determined as well as the dependence of the electric resistance on the temperature. (auth)

37122 METALLOGRAPHIC STUDY OF MICROSECTIONS OF URANIUM–IRON–COBALT ALLOYS. Sampaio, A. Oliveira. Prakt. Metallog., 1: 165-6(Dec. 1964). (In German)

A metallographic investigation was made on the ternary system U–Fe–Co and replicas for the microscopic identification of the phases alpha-uranium, $U_6(Fe, Co)$, UCo, and $U(Fe, Co)_2$. Microhardness and microstructure for these phases are given. (Rev. Metal Lit., Vol. 22, (June 1965))

37123 THE EFFECT OF METALLURGICAL VARIABLES ON SUPERCONDUCTING PROPERTIES. Livingston, J. D.; Schadler, H. W. Progr. Mater. Sci., 12: 106 (1964).

A comprehensive review of the ideal and experimentally determined properties of superconductors is presented. A summary of nonequilibrium behavior, along with resistance, magnetic force, torque, and internal field measurement techniques, and primary, secondary, and tertiary superconducting properties is included. 483 references are cited. (Rev. Metal Lit., Vol. 22, (June 1965))

37124 SOME MAGNETIC PROPERTIES OF METALLIC CERIUM. Pop, Iuliu. Studia Univ. Babes-Bolyai, Ser. Math.-Phys., 10: 147-50(1965). (In Rumanian).

The magnetic susceptibility of cerium was studied in the temperature interval from that of liquid nitrogen to the fusion point of Ce. The anomaly of the magnetic susceptibility around the temperature of 110°K was established. On the basis of the anomaly of the isotherms of the intensity of magnetization as a function of the magnetic field, the existence of an antiferromagnetic transition, accompanied by a change of the crystalline lattice, was assumed. The value of the effective moment of the magnetic susceptibilities, independent of the temperature, was in agreement with the theoretical data for the trivalent cerium ion and with other experimental data. (tr-auth)

37125 AN INVESTIGATION ON THE WC–TiC–TaC–Co CEMENTED CARBIDES. Kubota, Haruo; Hara, Akio (Sumitomo Electric Industries, Ltd., Osaka). Sumitomo Elec. Tech. Rev., No. 2, 86-91(July 1963).

Various cutting properties, mechanical properties at room and high temperatures and other properties were investigated in the relation of the composition on the WC-TiC-TaC-Co systems. In WC-(WTiTa)C-Co systems the toughness decreased with a decreasing WC-phase and the wear resistance, which was determined as cutting wear resistance, hardness, oxidation resistance, and adhesion resistance to steel, increased with a decreasing WC phase. With an increasing TaC content the toughness of (WTiTa)C-Co systems increased without losing wear resistance until the TaC/(TiC + TaC) ratio reached 90%. The cobalt phase changed remarkably with carbide composition. It was assumed that the properties of cemented carbides are influenced not only by carbide composition but also by the Co phase composition. (auth)

37126 DESORPTION ENERGIES OF GOLD AND COPPER DEPOSITED ON A CLEAN TUNGSTEN SURFACE. Godwin, R. P.; Luscher, E. Surface Sci., 3: 42-8(Jan. 1965).

Radioactive tracer techniques were used to determine the thermal desorption energies of Au and Cu from polycrystalline W surfaces. The observed binding energies are (3.6 + 0.5) and (3.5 + 0.5) ev for Au and Cu on W, respectively. (Rev. Metal Lit., Vol. 22, (June 1965))

37127 LOW ENERGY ELECTRON DIFFRACTION STUDY OF THE FORMATION OF TaO (111) ON Ta (110). Boggio, J. E.; Farnsworth, H. E. Surface Sci., 3: 62-70 (Jan. 1965).

LEED measurements and stopping potential measurements of changes in work function were used to study the nature of the oxidation product in the very earliest stages of the oxidation of the (110) faces of Ta single crystals. (Rev. Metal Lit., Vol. 22, (June 1965))

37128 A STUDY OF SPECIAL ELEMENTS IN STEEL. PART 5. THE EFFECT OF LANTHANUM ON STEEL. Narita, K.; Miyamoto, A.; Takahashi, E. Tetsu To Hagane, 50: 2011-13(1964).

The effect of La on the chemical and metallurgical behavior of steel was investigated. Specimen preparation and compositions are described. Data are given on sulfur printing, microstructure, nature of segregation of La, nonmetallic inclusions, austenite grain size, forgeability, mechanical properties of La-alloyed steels, and surface condition of ingots. The relationship between La, Ce, and U in liquid iron, on the one hand, and oxygen and sulfur on the other is discussed. The reason for difference in behavior between La and U is given. (Rev. Metal Lit., Vol. 22, (June 1965))

37129 A PRELIMINARY ANALYSIS OF A SET OF DISLOCATION RIBBONS OBSERVED IN A GRAPHITE FOIL. Lee, Jih-sheng; Guan, Rho-nan; Ho, I-djen. Wu Li Hsueh Pao, 21: 875-9(Apr. 1965). (In Chinese)

Dislocation ribbons were observed in a graphite foil by means of electron microscopy, using dark-field illumination. It was found that three types of ribbons, at varying levels of contrast, form the dislocation patterns. Comparison with previous studies revealed that the cause of formation of the ribbons is stacking faults in the graphite. The mechanism of the formation and the structure of the dislocations are discussed in detail. (TTT)

37130 ETCH SPIRALS IN GRAPHITE. Patel, A. R.; Bahl, O. P. (Sardar Vallabhbhai Vidyapeeth, Vallabh Vidyanagar, India). Z. Krist., 121: 392-9(May 1965).

The (0001) cleavages of natural single crystals of graphite were etched in a melt of hot sodium peroxide at temperatures between 360 and 450°C. The etch pattern, in addition to the normal hexagonal pits, consisted of spiraled etch pits revealing the sites of screw dislocations. Spiraled etch pits of both positive and negative nature were produced. The interlacing as well as interfering spirals originating from different dislocations were illustrated. It is shown that the spiral patterns similar to those formed due to growth, and observed on the natural faces of various crystals, can be produced by etching, the only difference between the two being that the growth patterns are elevations while the etch patterns are depressions. From the

centric nature of the etch spirals it was conjectured that the dislocations giving rise to these spiraled patterns are perpendicular to the cleavage face. (auth)

37131 DIFFUSION MEASUREMENTS IN THE SYSTEM COPPER–ZIRCONIUM. Hillmann, Gerhard; Hofmann, Wilhelm (Technische Hochschule, Brunswick). Z. Metallk., 56: 279-86(May 1965). (In German)

Diffusion in the system copper-zirconium was investigated at four temperatures. Microstructural observations indicated that after about 1000 hours six intermetallic phases are formed. This result was corroborated by micro-hardness measurements and concentration determinations by aid of an electron microprobe analyzer. It is suggested that the phases be described as $ZrCu_5$ (newly observed), $ZrCu_4$, $ZrCu_3$, $ZrCu_2$, ZrCu, and Zr_2Cu. The exponent in the growth rate equation varied from 1.5 to 3.5. In all diffusion couples a pronounced Kirkendall effect was observed. The weld plane was always located within the phase $ZrCu_5$ close to the copper interface. The specimens were contracted in the direction of diffusion. (auth)

37132 SOLUBILITY AND RATE OF DIFFUSION OF HYDROGEN AND DEUTERIUM IN NICKEL AND COPPER SINGLE CRYSTALS. Eichenauer, Walter; Loeser, Werner; Witte, Helmut (Technische Hochschule, Darmstadt, Ger.). Z. Metallk., 56: 287-93(May 1965). (In German)

The coefficients of solubility and diffusion of hydrogen and deuterium in nickel and copper single crystals are reported. An analysis of the coefficients of solubility indicated that the hydrogen and deuterium atoms in solution are probably located in octahedral sites. From the vibrational frequences of the hydrogen and deuterium atoms derived from the entropy of solution the temperature dependence of the solubility may be calculated with a singular vibrational frequency (Einstein model) as well as with a frequency spectrum (Debye model) within the limits of experimental error. The coefficients of diffusion may be discussed using Zener's theory within the accuracy of the measurements. (auth)

37133 ON ELECTRON BEAM MELTING, DEFORMATION, AND RECRYSTALLIZATION OF NIOBIUM AND TANTALUM. Zedler, Erich; Mueller, Dieter; Wiesner, Ulrich (Institut fuer Angewandte Physik, Deutsche Akademie der Wissenschaften, Dresden). Z. Metallk., 56: 316-19(May 1965). (In German)

The properties of niobium and tantalum melted in a 15-kw electron beam furnace were characterized by results of analyses, workability, and some mechanical properties in connection with recrystallization. During melting the furnace pressure appeared to be the most important factor. Poorer vacuum resulted in a higher oxygen content and in decreased workability. The results after strong deformation by rolling at room temperature and complete recrystallization (niobium for 1 hr at 900°C, tantalum for 1 hr at 1100°C) are reported. (auth)

37134 VAPOR PRESSURES OF SEVERAL CARBIDES AND HAFNIUM METAL BY THE LANGMUIR METHOD. Lyon, T. F. p.435-49 of "Condensation and Evaporation of Solids." New York, Gordon and Breach Science Publishers, 1964.

The evaporation behavior of TaC, WC, ZrC, HfC, TiC, and Hf metals was studied. Over-all evaporation rates were determined directly and relative evaporation rates of important vapor species were obtained from the variation in composition of the solid. For the congruently vaporizing materials, thermodynamic data were calculated. (Rev. Metal Lit., Vol. 22, (June 1965))

37135 MATERIALS SCIENCE RESEARCH. Volume 2. The Proceedings of the 1964 Southern Metals/Materials Conference on Advances in Aerospace Materials, held April 16-17, 1964, at Orlando Florida. Otte, Henry M.; Locke, Saul R. (Eds.). New York, Plenum Press, 1965. 327p. $13.50. (CONF-640411).

Seventeen papers presented at the 1964 Southern Metals/Materials Conference on Advances in Aerospace Materials, held at Orlando, Fla., April 16 and 17, 1964 are included. The papers are grouped into two parts, those dealing with basic observations and those concerned with applied problems. Separate abstracts were prepared for 11 of the papers. (F.J.H.)

For abstracts of individual papers see: 36641, 37136, 37137, 37138, 37139, 37140, 37141, 37142, 37143, 37144, and 37195.

37136 GRAIN BOUNDARIES IN CERAMIC MATERIALS. McGee, Thomas D. (Iowa State Univ., Ames). pp 3-32 of Materials Science Research. Vol. 2. New York, Plenum Press, 1965.

The importance of grain boundaries in controlling the properties of a wide variety of ceramic materials is reviewed. Results of original research on the effect of grain boundaries on the ductility of cubic ionic solids as a function of crystallographic orientation through the use of optical birefringence and transmission electron microscopic techniques are included. Theoretical models for grain boundaries were compared with actual boundaries. The theory of dislocation interaction with grain boundaries is discussed. The grain boundary model is a useful tool for comparing the work hardening of cubic ionic crystals with theoretical calculations. The sintering of ceramic oxides was diffusion controlled. The relative value of the diffusion constants for the surface, the volume, and the grain boundaries determine whether low porosity can be reached. Low porosity and fine grain size were essential to obtaining high strength and creep resistance. The impurity concentration at grain boundaries and in the bulk of the material can be used to control the sintering process. In the selection of impurities to control grain size and porosity, grain boundary diffusion mechanisms must be considered. The presence of grain boundaries can cause microcracks and brittle fracture by acting as a dislocation barrier. The effectiveness of the boundary in inhibiting dislocation motion was a function of the orientation of the crystal systems. Cubic ionic crystals of sodium chloride structure exhibited some ductility in polycrystalline form under controlled conditions. Thermal diffusivity of ceramic oxides at incandescent temperatures was a function of grain boundary concentration. Optical transparency of high density oxides was a function of grain boundary concentration. Magnetic properties of barium ferrite permanent ceramic magnets were dependent on grain boundaries to inhibit domain rotation. By contrast, soft ferrites had higher permeability when grain boundaries and porosity were at a minimum. (auth)

37137 DEFECT STRUCTURE AND ELECTRICAL PROPERTIES OF SOME REFRACTORY METAL OXIDES. Tallan, N. M. (Aerospace Research Labs., Wright-Patterson AFB, Ohio); Vest, R. W.; Graham, H. C. pp 33-67 of Materials Science Research. Vol. 2. New York, Plenum Press, 1965.

The equilibrium thermodynamic approach to the characterization of defect concentrations in refractory metal oxides as a function of temperature, oxygen partial pressure, and impurity content is given. Techniques for determination of ionic and electronic transport numbers by a blocking electrode polarization measurement and for the measurement of conductivity, thermoelectric power, and weight change are reviewed. The application of this approach and these measurements to the determination of the extent of deviation from stoichiometry, the nature and ionization state of the predominate defects, and the mechanism of charge transport are illustrated. Measurements on calcium-stabilized zirconia are cited as an example of an oxide in which the defect structure and conductivity were controlled by aliovalent foreign ions. This material was intrinsically a pure oxygen-ion conductor down to very low temperatures, but some electronic conductivity would be observed in the presence of certain impurities. Measurements on pure monoclinic zirconia at 1000°C are presented as an example of a transition metal oxide whose transport properties are essentially determined by its

deviations from stoichiometry. It is shown, for example, that, at 1000°C and high oxygen pressures, fully-ionized metal vacancies predominate and charge transport occurs by low mobility holes. (auth)

37138 EFFECTS OF PROCESS VARIABLES ON THE PROPERTIES OF MOLYBDENUM-TZM ALLOY SHEET. McNeish, W. A. (Universal-Cyclops Steel Corp., Bridgeville, Penna.). pp 135-48 of Materials Science Research. Vol. 2. New York, Plenum Press, 1965.

In molybdenum-TZM alloy, carbon is shown to be not simply a deoxidant, but an alloy addition affecting strength and recrystallization properties. The efficiency of the carbon could be varied by processing practices. For uniformity of sheet properties, carbon in the 0.020 to 0.030% range was desirable. The strength of sheet could be varied as the amount of total cold work was varied, but the recrystallization temperature was affected very little within the permissible cold-work range to produce good quality sheet. Rolling and annealing temperatures, likewise, had little effect on recrystallization temperature. Brittle transition and formability were sensitive to degree of cold work, rolling temperatures, in-process and final annealing temperatures, and surface condition of the sheet. When all variables were under control, sheet was produced with good recrystallization characteristics and bend transition temperatures of below −50°F with good formability. (auth)

37139 ARC-CAST TUNGSTEN SHEET PLATE AND BAR. Schoenfeld, W. J. (Universal-Cyclops Steel Corp., Bridgeville, Penna.). pp 149-61 of Materials Science Research. Vol. 2. New York, Plenum Press, 1965.

The production of tungsten base alloys is discussed. In a comparison of powder metallurgy and arc-cast products, the potential as well as the observed benefits of the arc-cast process must be analyzed. The purification and homogenization, which occurs during melting, should provide improved ductility and reliability in the end-products. In preliminary work on W-25Re, it was shown that alloying can greatly improve the ductile-brittle transition temperature (DBTT), particularly when the alloy is arc melted. (auth)

37140 DUCTILE CHROMIUM ALLOYS BY LIQUID-PHASE SINTERING. Van Thyne, R. J.; Steiner, R. E.; Holtz, F. C. (IIT Research Inst., Chicago). pp 163-75 of Materials Science Research. Vol. 2. New York, Plenum Press, 1965.

Ductility was demonstrated in chromium-rich, two-phase alloys prepared by liquid-phase sintering. Microhardness was employed to follow work hardening of the chromium grains and the matrix. Matching of the flow stress of the two phases appeared to be an important criterion. These principles were successfully applied to other refractory metal systems. (auth)

37141 LIGHTWEIGHT AEROSPACE MATERIALS. Flint, E. P. (Ipsen Industries, Inc., Rockford, Ill.). pp 193-209 of Materials Science Research. Vol. 2. New York, Plenum Press, 1965.

The primary objective of foamed materials development was to obtain refractory insulation for use at temperatures in excess of 4000°F in a vacuum or in other environments. The process used in preparing foams of refractory oxides and of metals depends on entrainment of air in a slurry of the powdered material, followed by drying and sintering. Firing in an oxidizing atmosphere was employed in manufacturing alumina and zirconia foams. Thoria foams were produced on a small scale. Foams were also made of molybdenum, stainless steel, Inconel, nickel, and tungsten by similar procedures, except that sintering had to be carried out in a vacuum, hydrogen, or another atmosphere in order to reduce the oxide film that surrounds the particles. Densities of the ceramic foams can be controlled at 10 to 50% of the theoretical values. Metal foams can be prepared in densities of 15 to 20% of the theoretical and higher. The foamed products, especially the metals, can be readily sawed and machined. Slight grinding of the foamed metal surfaces causes smearing and closing of the surface pores. Metal foams were readily brazed to solid metal in a vacuum furnace, and a strong composite was thereby obtained. Both ceramic and metal foams have many aerospace applications, the former for high-temperature insulation and structural components, and the latter for uses where reduction in weight and increase in resilience over the solid metal are important. (auth)

37142 HIGH-TEMPERATURE MATERIALS AND COATINGS FOR THE AEROSPACE INDUSTRY—THEIR PROCESSING, CHARACTERISTICS, AND APPLICATIONS (PART I). Love, R. W.; Esty, C. C.; Wheildon, W. M. (Norton Co., Worcester, Mass.). pp 211-34 of Materials Science Research. Vol. 2. New York, Plenum Press, 1965.

Ceramic materials are now coming into their own in the aerospace industry. Solid ceramics in combustion chambers and throats are replacing metals because of their extremely high fusion or decomposition temperatures. Coatings supplement both ceramic and metals by adding such properties as thermal insulation, erosion resistance, chemical resistance, and, in the case of metals, a temperature-resistant property. Information is given on solid ceramics such as the carbides, borides, and oxides. Data are given on oxide coatings such as alumina, zirconia, chromia, and nickel oxide. This data pertained to characteristics important to the aerospace industry, such as optical refractoriness and mechanical, electrical, and neutron shielding. Coating systems are explained in relationship to basic concepts and methods. Advantages of newer methods of ceramic coating techniques and their relationship to the aerospace industry are discussed. (auth)

37143 HIGH-TEMPERATURE MATERIALS AND FLAME SPRAY COATINGS FOR THE AEROSPACE INDUSTRY—THEIR PROCESSING, CHARACTERISTICS, AND APPLICATIONS (PART II). Love, R. W.; Esty, C. C.; Wheildon, W. M. (Norton Co., Worcester, Mass.). pp 235-44 of Materials Science Research. Vol. 2. New York, Plenum Press, 1965.

Information is given on solid ceramics such as the carbides, borides, and oxides. This includes the relationship of manufacturing technique to such properties as thermal shock, erosion resistance, and strength. Other properties important to aerospace applications, such as oxidation resistance and melting point, are discussed. Recrystallized silicon carbide now presently used in aerospace systems is discussed. (auth)

37144 GRAPHITE-BASE REFRACTORY COMPOSITES FOR AEROSPACE APPLICATIONS. Hiler, D. C.; Zeitsch, K. J. (Union Carbide Corp., Lawrenceburg, Tenn.). pp 261-73 of Materials Science Research. Vol. 2. New York, Plenum Press, 1965.

Improvements of graphite with respect to oxidation resistance, strength, and hardness are discussed. The manufacturing process employed was hot-pressing with final temperatures ranging from 1800 to 3200°C depending on the additives used and pressures up to 10,000 lb/in. were applied in some cases. The starting ingredients were powdery blends of graphite, pitch, and selected refractory materials not exceeding 30 vol %. The most effective additives were zirconium, silicon, niobium, thorium, and some of the rare earth metals. The relative evaluation of the resulting composites was primarily based on oxidation studies. The latter were conducted in various apparatuses with resistance heating, arc-image techniques, induction heating coupled with levitation, and arc plasma exposure. The composites formed an oxidation-resistant coating of the oxides of the additives, which enabled the material to withstand temperatures to 4000°F in an oxidizing atmosphere. Some of the composites were applied as thrust chamber liners for liquid-fueled, attitude-control motors with success. The theoretical flame temperature of the fuels ranged from 4000 to 5300°F. (auth)

37145 SINGLE-CRYSTAL FILMS. Proceedings of an International Conference held at Philco Scientific Lab-

oratory, Blue Bell, Pennsylvania, May 1963. Francombe, Maurice H.; Sato, Hiroshi (eds.). Oxford, Pergamon Press, 1964. 426p. 5 pounds. (CONF-630504).

Proceedings of a Conference on Single-Crystal Films are presented. Nucleation and orientation effects, epitaxial films, and physical properties of single-crystal films are discussed in the 27 papers. (M.C.G.)

37146 HIGH TEMPERATURE STRESS-RUPTURE CHARACTERISTICS OF Mo AND SOME Mo ALLOYS. Flagella, P. N. (General Electric Co., Cincinnati). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint AIAA Paper No. 65-567, 30p. $1.00. (CONF-650610-6). ORINS

From American Inst. of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs.

The stress-rupture characteristics of unalloyed molybdenum at 2200°C were experimentally determined to be dependent on whether it is arc-cast or wrought-sintered material. Three vendor sources of arc-cast molybdenum gave identical results whereas two sources of wrought-sintered molybdenum gave results which were different from each other and different from the results for arc-cast molybdenum. The differences are attributed to the differences in grain size. The arc-cast material has huge grains (500 to 900 microns) whereas the wrought sintered material has relatively fine grains (25 to 50 microns) even after 100 hours at 2200°C. Stress-rupture curves for arc-cast molybdenum from 1600° to 2400°C are presented as well as a plot of stress versus the Larsen-Miller Parameter. The constant in the L-M expression is determined to be 13.4. Also presented are the stress-rupture data for arc-cast molybdenum TZM at 2000° and 2200°C. The data indicate that the increased rupture life of TZM over unalloyed molybdenum is negligible at 2200°C. The stress-rupture data for wrought sintered Mo-50Re show it to have a rupture life approximately one order of magnitude greater than that for unalloyed molybdenum at both 1600°C and 2200°C. (auth)

37147 FUNDAMENTAL PHENOMENA IN THE MATERIAL SCIENCES. Volume 1. Sintering and Plastic Deformation. Proceedings of the First Symposium, held February 1, 1963, at Boston, Mass. Bonis, L. J.; Hausner, H. H. (Eds.). New York, Plenum Press, 1964. 139p. (CONF-630202)

Information is included on; sintering of metal powders; mechanisms of material transport and density-limiting characteristics in ceramic and metal sintering; sintering of polymer materials; plastic deformation in metals; dislocations in ceramic and metal crystals; and plastic deformation in polymers. A bibliography on theory and technology of sintering is included with 137 references published from 1958 to 1963. (P.C.H.)

37148 LATTICE DEFECTS IN QUENCHED METALS. An International Conference held at the Argonne National Laboratory, June 15-17, 1964. Cotterill, R. M. J.; Doyama, M.; Jackson, J. J.; Meshii, M. New York, Academic Press, 1965. 825p. (CONF-615). $22.00.

Proceedings of the International Conference on Lattice Defects in Quenched Metals are presented. Topics covered include: nonequilibrium situations involving vacancies in gold; quenching effects in the noble metals, nickel, and Ni-Co alloys; annealing-out of lattice vacancies in gold during and following rapid quenching; vacancy clusters in pure and impure fcc metals; methods of quenching; divacancies in pure metals; effects of impurity atoms on quenching and annealing experiments; resistometric researches on point defects in quenched Al and Al alloys; vacancies and vacancy complexes in quenched fcc metals; effects of quenched-in vacancies on mechanical properties of metals and alloys; structure and mechanical properties of quenched fcc metals; Zener relaxation studies of vacancy annealing in quenched alloys; point defects in quenched Pt; strains in quenched metals; specimen size and quenched-in lattice defects; pressure dependence of concentration and diffusion rate of lattice vacancies in metals; dislocation defects in quench-aged Al alloys; vacancy migration to sinks during quenches; small vacancy clusters in fcc metals; elastic energies of dislocation loops; annealing of quenched-in vacancies in gold; secondary defects in quenched Al; vacancy aggregates in quenched Cu single crystals; quenching of vacancies in W, vacancy loops in quenched Mo; effects of quenching on grain-boundary hardening in dilute Pb-Au alloys; and decoration of vacancies in quenched graphite. Five papers were previously abstracted for NSA as 18: 33178, 33179, 33180, 45194, and 19: 4648. (M.C.G.)

37149 HIGH TEMPERATURE COLUMBIUM BASE ALLOYS. (to United Aircraft Corp.). British Patent 989,405. Apr. 14, 1965. Filed May 18, 1962.

A Nb-base alloy consists of from 1 to 40 wt % of at least one of the elements, Ta, W, and Mo, from 0 to 10 wt % of at least one of the elements, Hf, Zr, and V, 0 to 4 wt % Cr, and from 0.05 to 0.3 wt % Be. The alloy has unusually high stress-rupture strength at temperatures up to at least 2200°F without any detrimental effect on either fabricability or room temperature ductility of the alloy. The alloy has good oxidation resistance and superior room temperature tensile strength. (B.L.M.)

37150 ALUMINUM-PLUTONIUM ALLOYS. Jones, Thomas Ivor (to Atomic Energy of Canada Ltd.). U. S. Patent 3,188,202. June 8, 1965. Filed Apr. 19, 1961.

Ternary alloys of Al, Pu, and one element selected from the group consisting of U, Si, and Ni have good corrosion resistance to high-temperature water and appear to be suitable for use in reactors. Preferably the alloys contain 4-6 wt % Pu and either 1-2 wt % Ni or 13-17 wt % Si or U. The alloys are prepared by reducing PuO_2 with excess Al metal in the presence of cryolite at about 1100-1200°C to produce billets of the desired composition. The billets are remelted and Ni, Si, and U are added in their elemental form. (A.G.W.)

37151 COLUMBIUM ALLOY. Michael, Arthur B. (to Fansteel Metallurgical Corp.). U. S. Patent 3,188,205. June 8, 1965. Filed Dec. 20, 1961.

Alloys having high strength and resistance to oxidation at elevated temperatures consist essentially of Nb, Ta, W and/or Mo, and Zr and/or Ti. Preferably the alloys also include oxygen in the range of 0.01-0.1% and carbon in the range 0.01-0.1%. The alloys may be prepared by conventional processes. (A.G.W.)

37152 COLUMBIUM ALLOY. Michael, Arthur B. (to Fansteel Metallurgical Corp.). U. S. Patent 3,188,206. June 8, 1965. Filed Dec. 20, 1961.

Alloys having high strength and oxidation resistance at elevated temperatures consist essentially of Nb, Ta, and Zr and/or Ti. Preferably the alloys also contain oxygen in the range 0.001-0.1% and carbon in the range 0.001-0.1%. The alloys may be prepared by conventional processes. (A.G.W.)

37153 MAGNESIUM-LITHIUM-THORIUM ALLOYS. Frost, Paul D.; Byrer, Thomas G. (to U. S. Army). U. S. Patent 3,189,441. June 15, 1965. Filed May 27, 1963.

A beta-phase alloy of Mg, Li, and Th has a good stability and hardness at elevated temperatures. Mg and Li are alloyed in the ratio by weight of 7.5 Mg to 1 Li, and amounts of Th not exceeding 5% of the total weight of the alloy are added. A metal selected from the group consisting of Al, Zn, and Zr may be added in amounts up to 5%. (A.G.W.)

37154 MAGNESIUM-LITHIUM-YTTRIUM ALLOYS. Frost, Paul D.; Byrer, Thomas G. (to U. S. Army). U. S. Patent 3,189,442. June 15, 1965. Filed May 27, 1963.

A beta-phase magnesium-base alloy having good hardness and stability at elevated temperatures consists essentially of 10-12% by weight Li and 4-6% by weight Y, the balance being Mg. Amounts of Th or Al up to 5% may also be added. (A.G.W.)

37155 HIGH-TEMPERATURE OXIDATION-RESISTANT COBALT BASE ALLOYS. Deutsch, D. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,202,506. Aug. 24, 1965.

Cobalt base alloys comprising lesser proportions of other alloying agents and a minor proportion of yttrium are described. The alloys are particularly suited for the manufacture of jet engine parts such as turbine blades, supercharger parts, etc., in view of the alloys ability to resist oxidation at temperatures up to 2300°F while simultaneously maintaining high strength at 1800°F and moderate strength at 2000°F. Specifically, the alloys comprise between about 61 and 54% cobalt, about 21% chromium, and about 10% tungsten; and additionally 7-12% of niobium, tantalum, or molybdenum, along with about 0.3 – 1.25% carbon and finally 0.9 – 1.3% of yttrium, proportions being generally in terms of weight %. (AEC)

Radiation Effects

***See also* CHEMISTRY — Radiation Chemistry.**

Refer also to abstracts 36048, 37353, and 37372.

37156 (AD-425904) ENERGY TRANSFER DURING TRANSIENT NUCLEAR PULSES. Progress Report No. 3, March 1, 1963-August 31, 1963. Kallmann, Hartmut P. (New York Univ., N. Y. Dep. of Physics). Nov. 1963. Contract DA 36-039 SC-89180. 29p. CFSTI, $1.60 cy.

High-energy radiation effects on insulators are examined. Ionization, excitation, and chemical changes occurring via radiation are examined. The radiation extends from soft x rays to γ rays. The general experimental techniques are included. (M.O.W.)

37157 (BNL-9127) EXPERIMENTAL STUDIES OF SOLID-STATE PROCESSES INFLUENCED BY IRRADIATION. Damask, A. C. (Brookhaven National Lab., Upton, N. Y. and Pitman-Dunn Research Inst., Frankford Arsenal, Philadelphia, Pa.). [1964]. Contract AT-30-2-GEN-16. 25p. (CONF-650904-2). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Symposium on Radiation Effects, Asheville, N. C.

A review is presented of radiation damage in alloys and its mechanisms. The microscopic effects occurring in such radiation damage are discussed; they include destruction of order, breakup of precipitate particles, enhanced nucleation, enhanced diffusion, and retarded diffusion. (D.L.C.)

37158 (BNL-9263) THE MOBILITY OF DISLOCATIONS NEAR THE DUCTILE TO BRITTLE TRANSITION TEMPERATURE IN IRRADIATED IRON. McRickard, S. B. (Brookhaven National Lab., Upton, N. Y.). [1965]. Contract AT(30-2)-Gen-16. 16p. (CONF-650904-10) Dep.(mn); $1.60(cy), 1(mn) CFSTI.

From Symposium on Radiation Effects, Asheville, N. C.

Fast neutron irradiation has been shown to increase the yield and flow stresses of iron and also to produce a transition from ductile to brittle behavior in tension near 125°K. A study of the effects of temperature and irradiation on dislocation kinetics near the yield point was performed to provide information on the above behavior. The variation of dislocation velocity with applied stress was studied at different temperatures before and after irradiation using a stress relaxation technique. The exponent m in the equation relating velocity and stress was found to equal approximately 20 for the initial Luder's band extension until the temperature is lowered below approximately 150°K where it begins to increase. Strain hardening also increases m. Irradiation increases m particularly at room temperature and then most sharply below the ductile to brittle transition temperature. However stress relaxation in embrittled iron below the extrapolated upper yield stress produced a delayed yield from which an m value equivalent to that just above the transition was calculated. The problem of ductile flow in the irradiated iron studied appears to be one of initiation of dislocation motion and the data seem to indicate a higher effective stress is required for dislocation motion in irradiated iron although the mechanism remains unchanged. Arguments are also presented that the assumption of a constant mobile dislocation density during stress or strain rate changes is not valid where m is found to increase sharply. (auth)

37159 (BNL-9289) EFFECT OF IRRADIATION ON DISLOCATION MOBILITY IN IRON STUDIED BY STRAIN RELAXATION. Chow, J. G. Y.; Rosenberg, R. (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT-30-2-GEN-16. 12p. (CONF-650904-5). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Symposium on Radiation Effects, Asheville. N. C.

Dislocation mobility in Ferrovac E iron irradiated for 4 hours ($\sim 5 \times 10^{15}$ nvt) and for 3 days ($\sim 1 \times 10^{17}$ nvt) was studied by observing the reverse relaxation in specimens strained 10 percent in torsion, held for a specified time, and then released to zero applied load. The resulting reverse relaxation curves were analyzed using the general equation for creep: $\dot{\gamma}_R = At_R^{(n-1)}$. An analysis is presented which suggests that irradiation reduces the tendency for cross glide, tangling, and also removes carbon from solution. An exposure of 1×10^{17} nvt appears to be sufficient to prevent cross glide. Removal of carbon from solution takes place progressively with increasing exposure. The results demonstrate that the technique is sensitive to the effects of an irradiation exposure as low as 5×10^{15} nvt. (auth)

37160 (BNL-9290) AN ELECTRON TRANSMISSION STUDY OF DEFECTS IN NEUTRON-IRRADIATED IRON Bryner, Joseph S. (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-2)-Gen-16. 7p. (CONF-650904-9) Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Symposium on Radiation Effects, Asheville, N. C.

Spots and loops which form during post-irradiation heat treatment of Ferrovac E irradiated to 2×10^{20} nvt are shown to be due to a defect which consists of one or more radiation defects plus oxygen atoms. The loop-forming defect does not contain carbon, nitrogen or hydrogen atoms without oxygen atoms. The defect diffuses with an activation energy of 39,000 calories per mole. Irradiation to 2×10^{20} nvt of iron poorer in oxygen produces other radiation defects which do not form visible structures during post-irradiation heating, but which can be converted to loop-forming defects by adding oxygen after irradiation. The irradiation-produced change in ambient-temperatures yield stress is insensitive to the ratio of loop-forming defects to convertible defects. It is shown that irradiation of iron containing appreciable nitrogen at temperatures appreciably higher than room temperature could produce structures similar to the spots and loops by nucleating precipitation of nitrides. (auth)

37161 (BNWL-56) TEST FOR MONITORING DIMENSIONAL CHANGES OF GRAPHITE IN ROD CHANNEL 74 AT N-REACTOR. Ryan, B. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1965. Contract AT(45-1)-1830. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Graphite samples are fabricated, annealed, measured, and placed in carriers for irradiation in rod channel 74 in NPR. The samples include both CSF and TSX samples. The tests are designed to measure the dimensional variations in graphite upon irradiation, as a function of sample size, material history, and position in a given sample. The experimental facility, experimental designs, and sample treatment and measurement are outlined. (T.F.H.)

37162 (BNWL-SA-236) RADIATION DAMAGE IN HEXAGONAL CLOSE-PACKED METALS AND ALLOYS Bement, A. L. (Battelle-Northwest, Richland Wash. Pacific Northwest Lab.). June 1, 1965. Contract AT(45-1)-1830. 63p. (CONF-650904-7) Dep. mn; CFSTI $3.00 cy, $0.75 mn.

From Symposium on Radiation Effects, Asheville, N. C.

The effects of radiation damage to hcp metals and alloys are discussed, based upon a comprehensive investigation

of Zircaloy-2. Irradiations were conducted at both 60 and 280°C to exposures extending to 2×10^{21} n/cm². Tensile properties were measured for transverse and longitudinal specimens taken from cold-rolled plate containing various levels of cold work. The effects of radiation damage to plastic flow and fracture behavior varied greatly with both irradiation and testing temperature. At exposures greater than about 5×10^{20} n/cm², damage at 280°C was greater than at 60°C. Even though changes in yield strength with neutron dose at 280°C fit a saturation model, saturation did not occur at the highest exposure obtained. The effects of crystallographic anisotropy are preserved and in some respects intensified by neutron damage. At high neutron doses at 280°C, yield strength becomes nearly independent of cold work indicating that radiation-induced hardening overrides strain-induced hardening. The above effects are discussed with reference to basic deformation and fracture mechanisms applicable to a variety of hcp metals and alloys. (auth)

37163 (CONF-650904-3) IRRADIATION BEHAVIOR OF URANIUM METAL TUBES IN A PRESSURIZED HEAVY WATER REACTOR. Angerman, C. L.; McDonell, W. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). [July 1965]. Contract AT(07-2)-1. 21p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Symposium on Radiation Effects, Asheville, N. C.

Zircaloy-clad uranium metal fuel tubes containing dilute (<1000 ppm) Fe, Si, and Al additions that were irradiated under 1200 psi reactor pressure to about 5000 Mwd/mt swelled less than 3%; in contrast, U–1.5 wt % Mo and unalloyed uranium tubes swelled 6 to 10%. The reactor pressurization contributed substantially to the good performance of the low-alloy tubes by limiting the volume increase that would normally be encountered at exposures beyond the characteristic threshold for swelling. (auth)

37164 (CONF-650904-4) EFFECTS OF MICROSTRUCTURE ON CAVITATIONAL SWELLING OF DILUTE URANIUM ALLOYS. McDonell, W. R.; Angerman, C. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). July 7, 1965. Contract AT(07-2)-1. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

For Presentation at Symposium on Radiation Effects, Asheville, N. C.

The resistance of a series of dilute low solubility uranium alloys to cavitational swelling in the temperature range from 400 to 500°C was defined in terms of irradiation exposures that could be reached before swelling began. Swelling resistance could not, however, be correlated with initial distributions of second-phase particles in the alloys as established by composition and heat treatment. Alloy phases were largely dissolved by irradiation during reactor exposure, and the swelling behavior of the several compositions apparently depended on the characteristics of the nonequilibrium solid solution formed during irradiation, rather than on the distribution of residual particles. (auth)

37165 (GEMP-47A, pp 85-99) EFFECT OF RADIATION ON HIGH-TEMPERATURE METALS AND ALLOYS. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Resistivity recovery studies of tungsten in the temperature region of 0.31 T_m were made on specimens irradiated at two different dosages (1.3 and 3.3×10^{-19} nvt, $E_n \geq 1$ Mev). Annealing one of the high dose specimens at a temperature of 850°C for times up to 100 hours shows that the defect density is still changing and that saturation recovery, therefore, has not yet been reached. Data reduction and analysis were initiated on this phase of the annealing studies. Hot-hardness measurements of irradiated molybdenum show results similar to those obtained for the case of irradiated tungsten specimens. A peak in the irradiation-induced hardness value appears at a temperature of approximately 160°C. In addition, the room temperature hardness values following annealing at a higher temperature show an increase in the radiation-induced hardening over and above that observed for the as-irradiated condition. These results (i.e., the further hardening) reflect similar trends observed in the room temperature yield properties of several BCC metals following irradiation. Recovery is observed to begin at a temperature of approximately 700°C and is apparently completed at a temperature of about 900°C. Preliminary studies on the effects of neutron irradiation on Hastelloy N specimens irradiated to a fast neutron dose of approximately 1×10^{20} nvt show about a factor of 10 reduction in the time to rupture when tested at a temperature of about 650°C. This material shows similar elevated temperature embrittlement to that observed in the Hastelloy X alloys when irradiated to comparable neutron dosages. (auth)

37166 (HW-84609(p.6.1-5)) GAS-COOLED REACTOR STUDIES. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

A correlation for use in comparing US and UK graphite irradiation data is described. From work on the tensile fracture strain of neutron-irradiated graphite it was concluded that specimens subjected simultaneously to stress and irradiation exhibit 0.10 to 0.20% more strain at failure than samples exposed to stress alone. (J.R.D.)

37167 (HW-84609(p.8.1-7)) IRRADIATION EFFECTS ON MATERIALS AND MATERIALS DEVELOPMENT. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Results of investigations concerning radiation swelling in fissionable materials are summarized. Results obtained in irradiation of Ni-base alloys are also included. Information on in-reactor measurements of mechanical properties of stainless steel, Hastelloy X, and Haynes 25 is given. Operation of ETR is reported. Radiation damage to Zircaloy-2 is discussed along with methods of determining effects of reactor environments on metal fracture, and in-reactor H_2-pickup by metals. Work in support of ATR gas loop is reported along with loop developmental work. (J.R.D.)

37168 (NASA-TN-D-2207) EFFECT OF ELECTRON IRRADIATION ON SOME PROPERTIES OF THE ECHO II LAMINATE. James, Thomas G. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Oct. 1964. 25p. CFSTI, $0.75 cy.

The primary effect of electron irradiation on the Echo II laminate, composed of 0.35-mil-thick plastic with 0.18-mil-thick aluminum foil glued on either side, was increased brittleness of the plastic which led to early and brittle failure in both the burst and ultimate-strength tests. Severe surface blistering, which occurred at total integrated flux on the order of 10^{17} electrons/cm², caused mechanical damage to the aluminum foil. (auth)

37169 (NP-15115) THE EFFECTS OF SPACE ENVIRONMENT ON MATERIALS. Chinn, J. L. (North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.). [1963]. 47p.

A discussion is presented of the space environment and its possible effects on spacecraft materials and components. The problem of space simulation tests on materials is considered, and charged-particle radiation effects are discussed. The costs of testing for charged-particle effects are considered, and it is concluded that the prediction of such effects from reactor (neutron and gamma) radiation effects would result in considerable savings. (D.L.C.)

37170 (ORNL-3807, pp 249-76) IRRADIATION TESTING OF COMPONENTS AND MATERIALS. Harms, W. O.; McCurdy, H. C.; Wechsler, M. S. (Oak Ridge National Lab., Tenn.).

Two types of in-reactor tube-burst tests on a 20% Cr–25% Ni–Nb-stabilized stainless steel were performed. The effect of heat treatment on the stress-rupture properties was investigated at constant stress at 650°C. Tubing having a fine-grained structure but with a coarse carbide phase, which was produced by annealing at 800°C, was substantially weaker than solution-annealed tubing but had much greater

ductility. Specimens of solution-annealed tubing were irradiated at 750°C without stress and then stressed at selected constant rates until failure while at temperature in the reactor. The irradiation had no detectable effect on strength, and the fracture ductility was unaffected except at low strain rates on specimens that had received thermal-neutron doses greater than 10^{19} neutrons/cm^2. Capsules containing UO_2 were irradiated at fuel temperatures exceeding 1900°C to burnups ranging from 0.01 to 1.0 at. % in order to measure fission-gas release and to study the effect of burnup on microstructure. The results indicated that virtually all fission gases were released from the fuel, even though a dense, columnar-grained structure formed after only a few hours of irradiation. Numerous lenticular voids were observed in the low burnup capsule in those portions of the fuel and insulation bushings where the calculated temperature exceeded 1700 to 1750°C, but no such voids were found in the other capsules. A plot of maximum grain size versus temperature showed that, in general, all specimens had the same grain size distribution, regardless of the irradiation time. Irradiation of capsule 03A-6, containing EGCR prototype-diameter fuel pellets, was terminated at an estimated burnup of 9476 Mwd/MT of UO_2. Capsule 04-8, which contains similar fuel, reached an estimated burnup of approximately 3980 Mwd/MT of UO_2. Fabrication of samples and the assembly of the surveillance strings were completed for the EGCR pressure-vessel surveillance program. Calculations were made concerning H_2 production in steel upon irradiation. A conservative expression that underestimates the neutron flux necessary to produce H_2 attack was used to obtain the H_2 production in a 1% manganese steel. In an irradiation experiment, no significant effect of gamma irradiation on H_2 permeation was found. (J.R.D.)

37171 (ORNL-P-1108) THE BEHAVIOR OF FISSION-GAS IN FUELS. Carroll, R. M. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 29p. (CONF-650904-1) Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

For Presentation of Symposium on Radiation Effects, Asheville, N. C.

A discussion is presented of the behavior of fission gases in UO_2 and of the factors influencing the fission product release from fuel. Attempts to calculate diffusion coefficients for fission gases in UO_2 are criticized, and the defect trap concept is considered. In-pile experiments on fission-gas release during irradiation of UO_2 under controlled fission density and temperature conditions are described. The tentative defect-trap model which was developed from the results of these experiments is described. The effects of fission rate, temperature, bursts, grain size, and recoil escape are discussed. (D.L.C.)

37172 (ORNL-P-1397) ATOMIC TRANSPORT PROBLEMS OF INTEREST IN NUCLEAR SYSTEMS. Lundy, Ted S.; Winslow, Fitz R. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 28p. (CONF-650704-2). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Thermodynamics, Vienna.

Several problems encountered in the application of basic diffusion data to systems of practical interest such as those encountered in nuclear engineering are discussed. These problems include isothermal diffusion experiments, thermal gradient diffusion, and radiation effects on diffusion processes. Recently it was demonstrated that indiscriminate use of an Arrhenius-type expression to describe the temperature dependence of diffusion data may lead to large errors in the prediction of diffusion coefficients. The ramifications of this finding are discussed with emphasis on refractory, body-centered cubic systems. The effect of a thermal gradient on the redistribution of substitutional impurities in a metal is studied. This work has led to an increased appreciation of the importance of this effect in systems of interest in the nuclear field. The enhancement of diffusion by radiation fields remains a problem of justified interest. Direct measurements of the effect of fast-particle bombardment on diffusion in a metal are reported. Results correlate well with predictions based on a model of the annihilation of excess point defects (vacancies and interstitials) by two mechanisms—migration to homogeneously-distributed fixed sinks such as dislocations, and recombination of defects. (auth)

37173 (ORNL-P-1448) THE EFFECT OF RADIATION ON ATOMIC REARRANGEMENTS IN Fe–N, Cu–Ni, AND Cu–Al ALLOYS. Stanley, J. T.; Williams, J. M.; Wechsler, M. S. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 16p. (CONF-650904-6). Dep. (mn); $1.00(cy), 1(mn) CFSTI.

From Symposium on Radiation Effects, Asheville, N. C.

The effect of neutron and electron irradiations at below room temperature on the precipitation, segregation, and short-range ordering processes in Fe–N, Cu–Ni, and Cu–Al alloys, respectively, was studied. Neutron irradiation, but not electron irradiation, is found to accelerate the precipitation of nitrides, which is attributed to the introduction of nucleation sites. However, at high electron doses, evidence is found for the trapping of nitrogen by radiation-produced point defects. For the segregation process in Cu–Ni and short-range ordering in Cu–Al, the reaction rate is increased by irradiation with neutrons and electrons. These are believed to be cases of radiation-enhanced diffusion, which occurs when radiation-produced defects become mobile at temperatures above −50°C. However, the identity of the defect responsible for the diffusion was not definitely established. (auth)

37174 (ORNL-P-1481) CURRENT PROBLEMS IN THE THEORY OF RADIATION DAMAGE. Holmes, D. K. (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 47p. (CONF–650904-8) Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From Symposium on Radiation Effects, Asheville, N. C.

The present status of the theory of radiation damage is reviewed. Emphasis is placed on the qualitative discussion of the points in the theory which appear to be most critical for a further advance in our understanding of the fundamental damage process. In particular, the need for a better knowledge of the effective interatomic potential is shown. (auth)

37175 (ORNL-TM-1142) IRRADIATION BEHAVIOR OF THORIUM-URANIUM ALLOYS AND COMPOUNDS. Olsen, A. R.; Trauger, D. B.; Harms, W. O.; Adams, R. E.; Douglas, D. A. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 63p. (CONF-650615-3). Dep.(mn); $3.00(cy), 2(mn) CFSTI.

From IAEA Panel on Utilization of Thorium in Power Reactors, Vienna.

Irradiation programs have been evaluating thorium-base compounds as part of the overall Thorium Utilization Fuel Cycle Program and in support of the Advanced Gas-Cooled Reactor Program. Thorium-base metal fuels are being considered for lower temperature reactor systems. Emphasis in the clad bulk oxide fuel program has been on the evaluation of the sol-gel derived ThO_2–UO_2 fuels, and vibratory compaction for fuel rod fabrication. The objectives of this program and the reported results are reviewed. Vibratorily compacted, sol-gel ThO_2–UO_2 has the characteristics of a useful power-reactor fuel. Experimental rods up to 36 in. in length fabricated in this manner have compared favorably with vibratorily compacted rods containing arc-fused ThO_2–UO_2 fuels and with rods containing pressed and sintered ThO_2–UO_2 pellet fuels. Tests at linear heat ratings between 300 and 400 w/cm have been examined with burnups in excess of 80,000 Mwd/t (Th + U) with less than 20% fission-gas release. Although the maximum performance capabilities have not been defined, rods have been operated at linear heat ratings of 1,000 w/cm to 22,000 Mwd/t (Th + U) burnup, with no evidence of swelling, or central melting and with fission-gas release rates less than 30%. Preliminary comparisons with similar UO_2 fuel rods indicate that higher power ratings are required to produce similar microstructural changes in the ThO_2–5% UO_2 fuels. Static and sweep capsules have been used in the irradiation tests of thorium-bearing fuels, both carbides and oxides, for application to high-temperature gas-cooled reactor designs. Fuel in the form of small particles, coated with pyrolytic carbon, has been irradiated in loose beds and

in graphite matrix elements. Reported data are reviewed, showing that spherical particles with multilayer coatings are superior and that fission-gas release rates (R/B) for ^{89}Kr of 10^{-5} to 10^{-7} have been achieved in loose bed tests. Coated particles of $(Th,U)C_2$ and $(Th,U)O_2$ compare favorably with similar UC_2 and UO_2 particles. The oxide particles are compatible with the intact pyrolytic carbon coatings. Metallic fuels, particularly thorium-base metal fuels, are being considered for reactors to supply heat for desalting water. A review of the limited experiments to date on thorium irradiations indicated that such isotropic fuels are not subject to the "growth" phenomena of anisotropic uranium and that they do not exhibit the "cavitation swelling" reported for uranium metal fuels in the 400 to 600°C temperature range. Additional research and development is required to define the usefulness of thorium-base metallic fuels. (auth)

37176 (ORNL-TM-1150) EXAMINATION OF IRRADIATED UO_2 PARTICLES FROM AEROJET GENERAL NUCLEONICS. Krohn, N. A.; Pearson, R. L. (Oak Ridge National Lab., Tenn.). July 1965. Contract W-7405-eng-26. 30p. Dep.(mn); $2.00(cy), 1(mn) CFSTI

Uranium dioxide (93% ^{235}U), with an average particle size of about 1 μ was slurried in liquid ammonia and circulated within the Materials Testing Reactor. Samples of the pre- and post-irradiated material were sent to ORNL, and the specific surface area and O/U ratio of each was determined and compared. An examination of the appearance of the particles before and after irradiation was performed by electron microscopy. The results showed the following: The circulating particles were comminuted, with a resultant fourfold increase in surface area. The O/U ratio was not affected. (auth)

37177 (VDDIT-16(5.1)) RADIATION EFFECTS ON SOLID, URANIUM BASED NUCLEAR FUEL MATERIALS. Volume 5, Number 1. A Bibliography. Uhlmann, W. (Aktiebolaget Atomenergi, Stockholm (Sweden)). May 1965. 50p. Dep. mn.

A bibliography dealing with 4 aspects of radiation effects on solid, uranium based nuclear fuel materials is presented. The four sections are: specification according to state, alloying and compounding components specified according to designation, factors influencing the behavior of materials subjected to irradiation, and effects of irradiation. (M.D.W.)

37178 DANGER FROM THE RADIOACTIVITY OF IRRADIATED SPECIMENS. Krasnoshchekov, M. M. At. Energ. (USSR), 18: 656-7(June 1965).

Measurements were taken of radiation doses of specimens of steel-45, cast iron, and red copper irradiated in a VVR-M reactor by 10^{16} to 10^{20} n/cm^2. The developed curves show that the dosage rapidly reduced in a month following irradiation with a neutron flux of 10^{16} n/cm^3 and in 6 to 7 months with 10^{19} to 10^{20} n/cm^3 flux. The dosage measured close to the wrought iron following six months after irradiation with 10^{16}, 10^{17}, 10^{18}, 10^{19}, and 10^{20} n/cm^2 was 0.45, ~1.6, ~8, 50, and 600 μr/sec, respectively. (R.V.J.)

37179 IRRADIATING MAGNETIC MATERIALS. Gordon, Daniel I. (Naval Ordnance Lab., Washington, D. C.). Electro-Technol. (New York), 75: 42-5(June 1965).

Data on neutron, proton, and electron irradiation of hard and soft magnetic materials are described which show how sensitive they are to various particle-radiation conditions and how improved magnetic properties can be obtained under specially controlled circumstances. In neutron irradiation of permanent magnets, hard magnetic materials are highly radiation-resistant. Limited study of the effects of proton radiation on magnetic materials was made. Pure iron and 5–80 Mo Permalloy ring samples, 0.01 in. thick, were irradiated with 1.5- and 4-Mev protons at exposures of up to 10^{16} and 10^{17} protons per cm^2 at 100°C. The only change was a 35% decrease in remanence and maximum permeability for the Permalloy and 10 to 20% for the iron. For 1.5-Mev proton irradiation of these materials, no magnetic changes occurred for doses less than 2×10^{14} protons per cm^2. The effects observed were due essentially to surface irradiation rather than the complete penetration obtained with neutrons and electrons of comparable energy. Results are also reported on electron irradiation of soft magnetic materials. Polycrystalline 5–80 Mo Permalloy, when irradiated with ~10^{17} 2-Mev electrons per cm^2 at ~100°C in the absence of an applied magnetic field, show increased coercive force and lowered remanence. But when a circumferential magnetic field of 0.2 oersteds is applied, remanence can be substantially increased while the original low coercive force is retained or even lowered. It was concluded that neutron and charged-particle radiation, in large enough doses, generally damages the useful magnetic properties of materials; however, when it is properly controlled and applied, irradiation with subatomic particles, especially electrons, can be used to improve the properties of materials. (TCO)

37180 PHOTOTROPY OF REDUCED SILICATE GLASSES CONTAINING THE 570 mμ COLOR CENTER. Swarts, E. L.; Pressau, J. P. (Pittsburgh Plate Glass Co., Penna.). J. Am. Ceram. Soc., 48: 333-8(July 1965).

Simple silicate glasses of high purity and melted under strong reducing conditions develop a characteristic visible color center on absorbing ionizing radiation. This center peaks at 570 mμ in soda-silica glasses but changes position depending on the specific modifier ions. The center grows to relatively large concentrations in glass irradiated by long wavelength ultraviolet light but also decays rapidly at room temperature, imparting phototropic response to the glass. The 570 mμ center probably does not require specific ion impurities; however, minor additions of Ce, Eu, and Zr enhance its formation in certain base compositions. Transition series elements, even in small concentrations, inhibit the center. Sustained irradiation by ultraviolet light leads to lower equilibrium concentrations of the center and hence to fatigue of phototropic response. (auth)

37181 RADIATION-INDUCED CONDUCTIVITY IN PLASTIC FILMS AT HIGH DOSE RATES. Compton, D. M. J.; Cheney, G. T.; Poll, R. A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Appl. Phys., 36: 2434-43(Aug. 1965).

A study was made of the radiation-induced conductivity (RIC) in poly[ethyleneterephthalate] (Mylar) films, using pulses of electrons of energies up to 30 Mev from a linear accelerator. The absence of polarization indicates that electronic conduction is responsible for the RIC, which has typical values of $\sim 10^{-8}\ \Omega^{-1}\ cm^{-1}$ at 5×10^9 rad(Mylar)sec^{-1}. The RIC is a bulk effect and shows both a "prompt" portion which falls very rapidly at the end of an electron pulse and a "delayed" portion which persists for milliseconds. The prompt portion varies as the 0.8 power of the dose rate and is independent of pulse width. The delayed portion varies as a lower power, saturating at dose rates of ~10^{10} rad (Mylar)sec^{-1}. The decay of the delayed portion is hyperbolic, and its rate is independent of temperature. The RIC increases monotonically with temperature in the range 100°–300°K. This behavior corresponds to a model in which one sign of carrier is rapidly and permanently trapped, the delayed conductivity being due to the other sign of carrier is rapidly and permanently trapped, the delayed conductivity being due to the other sign of carrier remaining free until it recombines. The saturation of the delayed conductivity is ascribed to a finite number of such traps. (auth)

37182 LOOP INTERACTIONS DURING ANNEALING OF NEUTRON-IRRADIATED MOLYBDENUM. Brimhall, J. L.; Mastel, B.; Bierlien, T. K. (Battelle-Northwest, Richland, Wash.). J. Appl. Phys., 36: 2585(Aug. 1965). (BNWL-SA-36)

Dislocation loops formed in molybdenum containing 450 ppm of carbon during irradiation at 40°C to an exposure of 10^{20} nvt and interacted during a 2-hr anneal at 750°C. The loops were studied by transmission electron microscopy. It was concluded that dislocation loops in irradiated molybdenum can have different Burgess vectors and that

these loops can interact with each other to form nodes during annealing. (D.C.W.)

37183 RADIOACTIVE DOPING OF CADMIUM SULFIDE FILMS AND ITS EFFECTS ON CHEMISORPTION. Fulkerson, W.; Hearn, C. L.; Leland, T. W. Jr. (William Marsh Rice Univ., Houston, Tex.). J. Catalysis, 4: 194-210(Apr. 1965).

Attempts were made to introduce impurities into a semiconductor material (and thus markedly influence its electrical conductivity) continuously from decay products of a nuclear reaction. In the experiments described, a radioisotope was introduced directly into the semiconductor. Continuous impurity doping of a semiconductor with the transmutation products of the decay of a radioactive isotope is demonstrated and it is shown that this doping predictably influences the electrical conductivity, Seebeck effect, and rates of chemisorption. By this technique the Fermi level of a semiconductor catalytic material could be altered over a wide range in a predictable manner without having to manufacture a new catalyst. Thin films of CdS containing ^{35}S were studied during the course of the β-decay of ^{35}S to stable ^{35}Cl. During this decay the electrical conductance increased with time in some cases by a factor of more than 100. External β irradiation of nonradioactive films with ^{35}S of comparable intensity caused some similar effects but of much smaller extent. The greater effect in the radioactive case was attributed to the build up of donor-type ^{35}Cl atoms introduced substitutionally into the lattice by the nuclear decay. Both the ^{35}Cl build-up and the β radiation caused an increase in the Fermi level which was found to inhibit the rate of ionized H adsorption in proportion to the degree of Fermi level elevation. However, the combination of heat treating and radiation effects, whether external or internal, offers a means of adjusting the Fermi level in a predictable manner to almost any desired level in the same catalytic or chemisorbing material. (BBB)

37184 THE EFFECT OF REACTOR IRRADIATION UPON HYDROGEN ADSORPTION BY AN ALUMINA CATALYST. Rosenblatt, D. B.; Dienes, G. J. (Brookhaven National Lab., Upton, N. Y.). J. Catalysis, 4: 271-7(Apr. 1965).

Hydrogen adsorption experiments were carried out on unirradiated and reactor-irradiated samples of gamma alumina (γ-Al_2O_3) in an effort to interpret the known enhancement by radiation of the catalytic activity of this material. The specific surface area of 85 m^2/g was not changed by irradiation, but the shapes of the H adsorption isotherms were altered. The observed monolayer capacity for hydrogen indicates that H atoms are adsorbed (at 78°K) in one-to-one correspondence with the O ions in the alumina surface. Nitrogen contamination, which is not removed by outgassing at 300°C, was detected. It is displaced systematically as H is adsorbed at 78°K. Reactor irradiation appears to enhance this N release phenomenon. The existence of an original layer of adsorbed N may be of significance for a qualitative understanding of the catalytic properties of gamma alumina. It is known that the unirradiated material has a variable catalytic behavior depending upon the heating and outgassing procedures used, and the choice of degassing technique affects the subsequent radiation enhancement of the material's catalytic activity. No increase in catalytic activity is seen when it is irradiated in vacuum, but an increase occurs when H is in contact with the alumina during irradiation. This is in accord with the conclusions reached here, i.e. that irradiation in vacuum does not remove the nitrogen contamination but N is replaceable by H. (TCO)

37185 NEUTRON IRRADIATION EFFECTS IN AUSTENITIC STAINLESS STEELS AND A NIMONIC ALLOY. Broomfield, G. H.; Harries, D. R.; Roberts, A. C. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Iron Steel Inst. (London), 203: 502-6(May 1965). (AERE-R-4745)

A study was made of factors responsible for the effects of neutron irradiation on the room- and elevated-temperature tensile properties of two austenitic steels (20% Cr-25% Ni-Nb-stabilized and AISI 316) and a precipitation-hardening nickel alloy (Nimonic PE16). Neutron irradiation produced hardening and loss of ductility of all the alloys at test temperatures below about 500°C, the magnitudes of the effects increasing with increasing fission (or fast) neutron dose. Irradiation also reduced the elongation values at test temperatures above 650-700°C for the austenitic steels, and at 600°C and above for the Nimonic PE16 alloy. The elevated-temperature tensile ductilities of the Nimonic alloy were affected to much greater extents for a given neutron exposure than those of the 20% Cr-25% Ni-Nb-stabilized steel. Here the reductions in ductility were due primarily to the thermal (or slow) neutrons. Results show that the reductions in the elevated-temperature ductility of austenitic steels can be correlated with the number of He and/or Li atoms introduced by transmutation of the ^{10}B isotope of natural B. The evidence that an irreversible transmutation reaction is involved is further supported by the observation that postirradiation annealing at temperatures up to 1170°C does not enable the reductions in the elevated-temperature tensile ductility of austenitic steels to be recovered. (TCO)

37186 EFFECTS OF NEUTRON DOSE RATE AND IRRADIATION TEMPERATURE ON RADIATION HARDENING IN MILD STEELS. Barton, P. J.; Harries, D. R.; Mogford, I. L. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Iron Steel Inst. (London), 203: 507-10(May 1965).

Results are reported on the combined effects of neutron dose rate and temperature on radiation hardening in three different mild steels irradiated under identical conditions. An En2 mild steel, an aluminum grain size controlled mild steel, and a silicon killed mild steel were used. Wire tensile specimens prepared from the three mild steels were tested at room temperature after irradiation to approximately the same neutron dose at accurately controlled temperatures in the range 100° to 350°C in the PLUTO reactor. The reactor was operated at three power levels giving relative neutron dose rates of 1:4:100. Neutron irradiation at temperatures in the range 100 to 350°C produced increases in the lower yield and ultimate stresses and reductions in the elongations to fracture of all three mild steels in room temperature tensile tests. The increases in yield stresses were dependent on the irradiation temperature and the type of steel but independent of the neutron dose rate. Radioinduced hardening was maximum after irradiation at 100°C and became progressively less after irradiation at higher temperatures. The susceptibilities of the respective steels to radiation hardening were different, particularly after irradiation at temperatures of 100-250°C; the aluminum grain size controlled mild steel was the most resistant and the En2 steel the least resistant to radiation hardening. It is suggested that the variations in the hardening of the respective steels are due primarily to differences in their interstitial N contents. The N in interstitial solution probably associates with the irradiation-induced defects in a manner similar to that postulated for carbon. (BBB)

37187 OBSERVATION OF URANIUM FISSION TRACKS BY ELECTRON MICROSCOPY IN MICA AND MOLYBDENITE. Debeauvais, Monique; Muller, Charles; Rebstein, Elisabeth (Centre de Recherches Nucléaires, Strasbourg-Cronenbourg, France). J. Microscopie, 3: 153-8(Apr. 1964). (In French)

Damage induced by U fission tracks in mica and molybdenite crystals was observed. In a preliminary study the tracks were observed after chemical attack with HF. The reagent was used for periods of 2 min 30 sec and 10, 20, and 30 min on samples of mice that had been in contact with U. Illustrations of the ends of the tracks are given. A sample maintained several microns from the U and attacked by HF for 30 min showed the end of the track with discontinuous alterations resembling points, as well as continuous alterations. The dimensions of the fission tracks

are a function of developing time and range from 290 Å at 2 min 30 sec to 600 Å at 30 min. Samples of thickness less than 1000 Å should be chosen for observation of primary tracks; a convenient method for choosing samples includes floating them on water with 10% acetone and observing their color in reflected light, which is nearly uniform. Samples are best examined after selection at low temperatures; the design of an apparatus which maintains samples at −80°C is illustrated; it has been improved to use liquid N_2. At maximum refrigeration, resolving power was 16 Å. The mean length of tracks in synthetic mica and molybdenite was found to be about 150 Å. (BBB)

37188 BERYLLIUM-ALUMINUM ALLOYS. Fenn, Raymond W. Jr.; Glass, Richard A.; Needham, Robert A.; Steinberg, Morris A. (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Spacecraft Rockets, 2: 87-93(Jan.-Feb. 1965).

Some Be-Al sheet and extrusions containing 24 to 43 wt % Al were produced which have significantly improved ductility as compared to Be. The effects of radiation on Be and Be alloys for space flight was examined from the standpoint of both structural properties and secondary radiation production. Proton radiation in the Van Allen belt and solar flares can induce the important transmutation reaction $^9Be(p,pn)^8Be$, which immediately leads to two He atoms. At 10^{-24} cm^2 as a reaction cross section and 10^6 protons/cm^2/sec as the maximum flux that would be encountered either in the Van Allen belt or from solar flares, degradation of Be structural properties in space vehicles will not be a problem. Calculations of neutron production from Be by space radiations were made to demonstrate that this nuclear characteristic of Be does not constitute a potential health hazard for space missions. Data for Van Allen protons and results of calculations for several space missions are given. In all cases, the dose rates are in the Mrad/day region, which are equal to or less than the normal cosmic-ray exposure (10-20 Mrad/day). Since doses near 100 Rad are required for a severe hazard to man, it was concluded that the production of neutrons from Be does not constitute a significant health hazard for missions of reasonable duration. (TCO)

37189 PERFORMANCE OF PROTOTYPE EXPERIMENTAL GAS-COOLED REACTOR FUEL UNDER EXTREME CONDITIONS. Osborne, M. F.; Long, E. L. Jr.; Morgan, J. G. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 22: 420-33(1965). (ORNL-P-100)

A series of experiments to test the Experimental Gas-Cooled Reactor (EGCR) fuel element concept was conducted in the Oak Ridge Research Reactor and the Engineering Test Reactor. The elements tested were sintered UO_2 fuel pellets contained in stainless steel tubing. Principal test variables were fuel pellet geometry, cladding temperature, and fuel burnup. After irradiation, the elements were examined for dimensional stability, integrity of the cladding, the fractional release of fission gas from the fuel, and any interactions between the fuel and the cladding. Some elements were subjected to unusual and extreme conditions of operation and others were not built to EGCR specifications. Such elements experienced three types of failure: severe cladding fractures, microscopic cladding defects, and failures in associated components. Detailed examination of these experiments showed potential problems which may occur if EGCR fuel elements are operated outside design conditions. (auth)

37190 EFFECT OF GAMMA RADIATION ON THE OPTICAL ABSORPTION OF LEAD SILICATE GLASS. Barker, R. S.; McConkey, E. A. G.; Richardson, D. A. (Pilkington Brothers Ltd., Lathom, Eng.). Phys. Chem. Glasses, 6: 24-9(Feb. 1965).

A study was made of the effects of ~1-Mev (spent fuel) γ radiation doses in the range 0.01 to 100 MRad on the optical absorption of lead silicate glass. The radioinduced absorption spectrum between 1.2 and 3.5 ev is shown to consist of two bands centered at 2.36 and 3.31 ev. The induced coloration of each band fades according to: $\log \alpha = k \log (t + c) + b$, and a model in accordance with this equation is proposed. The variation with radiation dose of each absorption band is shown to consist of two superimposed portions, a saturation curve, and a linear part. Strain produced by heat treatment of the glass is released on γ irradiation. For a given radiation dose the coloration induced in heat-treated glass is greater than that in annealed glass; this is attributed to the creation of defects by the heat treatment. The bleaching rate is increased by raising the temperature and by exposure to light. The absorption bands induced in lead silicate glass by a radiation dose of 10^8 Rad may be completely removed by exposure to light from a uv lamp (Philips type 57265 F/28) for 1 hr. It might be expected that the effect of this irradiation would be to free the electric charges from the defects containing them but it should not be sufficiently energetic to destroy the defects themselves. It would thus be expected that successive irradiations by a given dose with complete optical bleaching between irradiations should show a progressively higher absorption with each irradiation. This phenomenon was demonstrated. (TCO)

37191 MEASUREMENT OF THE ENERGY LOSS OF GERMANIUM ATOMS TO ELECTRONS IN GERMANIUM AT ENERGIES BELOW 100 kev. Chasman, C.; Jones, K. W.; Ristinen, R. A. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 15: 245-8(Aug. 9, 1965).

The results of direct determination of the energy loss to electron collisions of germanium atoms in a germanium environment are presented. Spectra for the lines of germanium-72 and for germanium-74 produced by neutrons incident on the counter are shown. The gamma-ray line from germanium-74 is at 596 kev and the conversion-electron line from germanium-72 at 690 kev. All measurements were made with a cesium-137 source present to provide a measure of the system resolution and stability. The quantity related to the fractional energy loss is found to vary exponentially with the dimensionless measure of the germanium recoil energy. (J.F.P.)

37192 RECRYSTALLIZATION OF NEUTRON-IRRADIATED AND COLD-ROLLED POLYCRYSTALLINE COPPER. Christ, W.; Gschwendtner, K.; Haessner, F. (Max-Planck-Inst. of Metallurgy, Stuttgart). Phys. Status Solidi, 10: No. 1, 337-44(July 1, 1965). (In German)

Polycrystalline copper is irradiated above room temperature with neutron doses up to 6.3×10^{20} neutrons/cm^2 (≥0.1 Mev), then cold rolled up to a cross-section reduction of 97%, and subsequently annealed at 200°C. The recrystallization is followed rotentgenographically with 111-pole figures. The rolling texture is not changed by the neutron irradiation for degrees of rolling higher than 95%, but the recrystallization terminates more rapidly. The acceleration of recrystallization for a degree of rolling of 95% is higher than for 97%. Both effects, the acceleration of recrystallization and the dependence on the degree of deformation, can be explained by an increase in the mean mobility of the atoms due to the destruction of large and relatively stable dilute zones in the irradiated material. (auth)

37193 GAMMA-RADIATION-INDUCED CONDUCTIVITY IN GLASSES. Culler, V. E.; Rexford, H. E. (Corning Glass Works, Plainsboro, N. J.). Proc. Inst. Elec. Engrs., (London), 112: 1462-7(July 1965).

Determinations of the charges in the electrical conductivities of several different types of glasses during γ irradiation were made. Fused silica, aluminosilicate, borosilicate, and alkali lead-silicate glasses were among the types examined. The fused silica exhibited the most pronounced change in conductivity. For example, at a dose rate of 10 rad(H_2O)/s, the conductivity at room temperature exceeded 10^{-15} mho/cm. This contrasted with the value of approximately 10^{-20} mho/cm, taken from data extrapolated to room temperature for the same glass in the absence of radiation. The effects of dose and dose rate on the conductivity of fused silica were also investigated as a function of temperature. Results are analyzed on the basis of Rose's theory of photoconductivity. (auth)

37194 ON THE POSSIBLE MECHANISMS ON THE INFLUENCE OF RADIOACTIVE IMPURITIES ON THE CATALYTIC AND CHEMOSORPTION PROPERTIES OF SEMICONDUCTORS. Baru, V.; Wolkenstein, Th. (Inst. of Physics and Chemistry, Moscow). Z. Physik. Chem. (Leipzig), 228: 193-205(1965). (In German)

The effects of ionization and charging of a semiconductor from radioactive self-irradiation on its catalytic and chemosorption properties was investigated on the basis of the electron theory of catalysis. The dependence of the absolute magnitude and sign of the effect on the specific radioactivity and the history of the sample were analyzed. It was shown that the effect of charging is preponderant at small specific radioactivity and that the effect of ionization is preponderant at high specific radioactivity. Through the concurrence between both these factors, both a positive and a negative effect can be obtained for the same adsorber-absorbant system, according to the conditions of the experiment. (tr-auth)

37195 DIRECT OBSERVATION OF RADIATION DAMAGE IN MOLYBDENUM. Meakin, J. D.; Lawley, A. (The Franklin Inst. Labs., Philadelphia). pp 69-90 of Materials Science Research. Vol. 2. New York, Plenum Press, 1965.

The effects of neutron irradiation, both at ambient and elevated temperatures, on the structure of molybdenum were studied and compared and contrasted with previous observations on copper and nickel. The defect structures produced by neutron irradiation at doses up to 10^{20} nvt, at temperatures from ambient to 600°C, are being studied using transmission electron microscopy. For low doses, 10^{18} nvt at 600°C, large prismatic dislocation loops (average diameter 1100 A) were observed on planes approximately parallel to {111}, and having the normal slip vector $\frac{1}{2}\langle 111\rangle$. Diffraction contrast experiments were carried out on these loops, which proved conclusively that these were formed by the collapse of interstitial aggregates. By comparison, ambient temperature irradiation to this dose level produced a structure with a high density of spots, which were not readily resolvable as loops. Specimens were also irradiated to $\sim 10^{20}$ nvt at ambient temperature and were found to contain a higher density of the unresolved damage. The mechanism of the formation of the loops and their interaction with glide dislocations is discussed. (auth)

37196 BESTRAHLUNGSEFFEKTE IN FESTKORPERN. EINE EINFUHRUNG IN DIE THEORIE. (Irradiation Effects in Solids. An Introduction to the Theory). Leibfried, Guenther. Teubners Physikalisch-Technische Sammlung. Stuttgart, B. G. Teubner Verlagsgesellschaft, 1965. 28ep.

An introduction to the theory of radiation effects in solids is presented as a textbook for college students. The description of collisions by effective cross sections is defined and examples of collision theory are given. The primary distributions, the theory of defect production, the spatial expansion of a cascade, lattice effects, and special problems are discussed. (J.S.R.)

37197 EVALUATION OF THERMAL NEUTRON INDUCED ERRORS IN THE W/W-25Re THERMOCOUPLE. Kuhlman, W. C. (General Electric Co., Cincinnati). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint AIAA Paper No. 65-563, 11p. $1.00. (CONF-650610-4). ORINS

From American Inst. of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs.

The W/W−25Re thermocouple is a practical thermocouple for measuring high temperatures deep inside nuclear reactors. The gradual transmutation with time of the tungsten and rhenium in the thermoelements into osmium causes the thermoelectric output to change. Alloys were prepared to represent the composition of the tungsten and W−25Re thermoelements after an exposure at 10^{14} nv thermal for a number of specific times, as predicted by theoretical calculations. The thermoelectric properties of these materials were compared with those of the untransmuted tungsten and W−25Re materials. The difference or error in °C is shown as a function of time for various temperatures to 2000°C, and as a function of temperature for various times of neutron exposure. Also shown is the error that each thermoelement contributes to the over-all error of the tungsten versus W−25Re thermocouple due to nuclear transmutation. The error of W-1% Os versus W−25Re thermocouple is shown to have less error than the above thermocouple. A relatively convenient method of preparing samples of alloys for thermoelectric testing is described which may have general application. (auth)

METEOROLOGY

See also GEOLOGY AND MINERALOGY — Site Survey and Selection.

37198 (BNWL-SA-123) DEVELOPMENT OF AN ATMOSPHERIC TRANSPORT MODEL. Fuquay, J. J.; Simpson, C. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 5, 1965. Contract AT(45-1)-1830. 25p. (CONF-650407-10) Dep.(mn), $1.00(cy), 1(mn) CFSTI

From International Symposium on Fission Product Release and Transport Under Accident Conditions, Oak Ridge, Tenn.

The dilution of material released to the atmosphere depends on the time of travel and the lateral and vertical growth of the cloud. It is shown that diffusion data stratify well in terms of stability when plotted in terms of the travel time, a significant improvement on the usual distance relationships. The lateral growth, σ_y, varies as the first power of time, t', initially and varies as $t'^{\frac{1}{2}}$ in the limit. σ_y can be uniquely determined from the standard deviation of the wind direction and the mean wind speed, statistics which are routinely recorded. These results permit the assessment of the consequences of rather long releases in which exposure isopleths may take complex forms. (auth)

37199 (FTD-TT-65-342) TRANSPORT OF RADIOACTIVE AEROSOLS IN THE TROPOSPHERE FROM THE NORTHERN TO THE SOUTHERN HEMISPHERE. Krasnopevtsev, Yu. V. Translated from Meteorol. i Gidrol., No. 4, 3-8(1964). 12p. CFSTI.

An attempt was made to evaluate the rate of transition through the equatorial zone of radioactive aerosols from nuclear explosions in the northern hemisphere. Measurements of the air radioactivity and the radioisotopes therein were made on a research ship in the Indian and Pacific Oceans, from Sept. 20, 1961 to Jan. 25, 1962. The maximum in the β activity occurred between 25 and 35°N. The results indicate a transition time of 3 to 3.5 months. An estimate was made of the meridional component of the horizontal diffusion coefficient in the troposphere. (D.L.C.)

37200 (JPRS-30925) BIBLIOGRAPHY OF SOVIET PUBLICATIONS ON ROCKET AND SATELLITE INVESTIGATIONS OF THE UPPER ATMOSPHERE AND OUTER SPACE IN 1964. Translation of p.82-117 from Investigations of the Upper Atmosphere and Outer Space Carried Out in the USSR in 1964, made at Eighth Meeting, Buenos Aires, Argentina, May 1965. 29p. (TT-65-31424). CFSTI, $2.00 cy.

A total of 269 references are presented under the following headings: general problems, flight dynamics, upper atmosphere, particles and magnetic fields, satellite and rocket meteorological investigations, and medical and biological investigations. (D.L.C.)

37201 THE SIZE DISTRIBUTION OF RADIOACTIVE AEROSOLS IN THE UPPER TROPOSPHERE. Chagnon, Charles W.; Junge, Christian E. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Appl. Meteorol., 4: 329-33(June 1965).

An aircraft-borne impactor-filter system for the collection of tropospheric aerosols of natural and fission-product origin is described. The system was used in studies of the size distribution of atmospheric particles as a function of altitude within the troposphere. Preliminary results indicated a size distribution in mid-troposphere as being intermediate between ground level and lower stratosphere and supported the possibility that high level particles undergo a change in size on their descent through the atmosphere. (auth)

PHYSICS

General

Refer also to abstract 36220.

37202 (BNL-900(p.1-28)) REACTOR PHYSICS DIVISION. Chernick, J.; Kouts, H. (Brookhaven National Lab., Upton, N. Y.).

During the year a series of eight lattice configurations of the 3% enriched $^{235}UO_2$–ThO_2 fuel rods in clean, water-moderated systems was investigated and a second series of measurements on boric acid-poisoned water lattices was completed at water-to-fuel volume ratios ranging from 3:1 to 6.8:1. Pulsed neutron measurements in the poisoned lattices and integral measurements on miniature $^{233}UO_2$-ThO_2 lattices were begun. Critical experiments were performed on epithermal, semihomogeneous ^{235}U-graphite assemblies and pulsed neutron experiments were completed on diffusion coefficient anisotropy in composite stacks of Al and polyethylene. Measurements of flux fine structure in slightly enriched U-water lattices are reported. The work on critical experiments in support of safety studies for the High Flux Beam Research Reactor (HFBR) was completed during the year. A new and flexible source reactor facility is in its final stages of construction. Preliminary analysis of ^{233}U-fueled critical experiments is reported. The epithermal capture-to-fission ratio of ^{233}U is found to be to about 0.17. In an analysis carried out on D_2O-moderated natural U rod lattices it was found that the average eigenvalue obtained (0.993) exhibits only slight dependence on rod size, lattice pitch, or buckling. A program designed for undermoderated lattices to obtain integral data for the verification of epithermal neutron cross sections was developed. Continued study of neutron thermalization processes and the allowed spectrum of eigenvalues which play a central role in the analysis of time-dependent problems are reported. The stability of two-phase flow in a heated tube was investigated by a new analytical model. Studies were also carried out for potential and viscous fluid flow past arrays of obstacles such as a line of spheres or discs. The main effort of the Sigma Center during the year was devoted to the completion of new supplements of BNL 325 on neutron cross sections of the first twenty elements. Computer programs for filing and retrieving cross section data on magnetic tapes were completed. Studies in the statistical theory of the compound nucleus and in the theory of cross section fluctuations in the continuum region were carried out. Development of the Settled Bed Fast Reactor (SBFR) concept dealing primarily with the properties of ordered packed beds is reported. Methods of obtaining such beds by the settling or random dropping of spheres into rigid columns were perfected. A study of the economic potential of a 1000-Mw(e) fast settled bed breeder based on UC-PuC fuels was carried out. A technique was developed for accurate determination of the distribution of sphere centers in packed beds. Programming and checkout of THORCYC for cost analysis of batch irradiation cycles for fast, Th-fueled breeder reactors were completed, and a study of the characteristics of chemonuclear reactors for production of ozone was carried out, as was a comparative study of thermal and epithermal reactors for Cf production. Work continued on the development of a closed-cycle electrochemical converter based on the system Pb-$PbBr_2$-Br_2. Studies were continued on a liquid-metal MHD generator. (J.R.D.)

37203 (LA-3262) ON THE PROPER USE OF TRANSFORMATIONS OF LOG NORMAL FUNCTIONS IN SMALL PARTICLE STATISTICS. Goldman, A.; Lewis, H. D.; Moore, R. H. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Dec. 1964. Contract W-7405-eng-36. 32p. Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

A standard notation is suggested for use in all fields concerned with small particle data analysis. The representation of particle size data by various forms of the log normal function is discussed and related to methods of "particle size" measurement. Transformations among parameters defining the functions are discussed, and the general functional relationships are developed and listed in tabular form. The use of the proper parameters for data comparisons or for distribution definition is emphasized. (auth)

37204 (NP-15189) EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH ANNUAL REPORT, 1964. (European Organization for Nuclear Research, Geneva (Switzerland)). 174p. Dep. mn.

An improvement in several instruments is reported. The PS puts out an intensity of 10^{12} protons per pulse and is now able to maintain this intensity for a considerable period. A radio-frequency separator was operated successfully. Bubble chamber and data processing improvements are reported. Scientific results are reported. Bibliographies of work at CERN are presented. (M.O.W.)

37205 (ORNL-3778) PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1964. (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 202p. Dep.; $6.00 (CFSTI).

Thirty-nine sections are included; separate abstracts have been prepared for 30. One of the sections was abstracted previously in NSA, 19: 23397. The remaining 8 sections consist of: infrared studies of second-order transitions in CF_4; the design of a low-temperature liquid infrared absorption cell; and short descriptive sections on relativistic quantum mechanics, nuclear shell model, fission of oriented nuclei, and nuclear-data tabulations. (T.F.H.)

For abstracts of individual sections see: 36813, 36814, 37042, 37247, 37456, 37457, 37458, 37763, 37800, 37801, 37802, 37803, 37804, 37805, 37806, 37807, 37808, 37809, 37810, 37811, 37812, 37813, 37814, 37815, 37816, 37817, 37818, 37819, 37820, and 37821.

37206 (SC-R-64-1378) PROPAGATION OF AN ELECTROMAGNETIC WAVE IN A TIME-VARYING MEDIUM. PART II. SQUARE-WAVE MODULATION OF THE PERMITTIVITY. Kunz, Kaiser S. (New Mexico State Univ., University Park). Dec. 1964. Contract AT(29-1)-789. 42p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The propagation of electromagnetic waves in a medium whose effective dielectric constant and conductivity vary with time according to a square-wave modulation is studied. The equation for the static case is solved, and simplifications from the use of eigenvalues and eigenvectors are discussed. Square-wave modulation of a lossless medium, with constant zero conductivity, is considered for the dynamic, stable, and transition regions. Regions of stability and instability are defined for the case where the time spent by the permittivity at its higher value equals that spent at the lower value. The behavior of the solutions is studied for symmetry with respect to space and time reversals. (M.J.T.)

37207 UNITS FOR ATOMIC AND SUBATOMIC PHYSICS. Barkas, Walter H. (Univ. of California, Berkeley). Am. J. Phys., 33: 584-6(July 1965).

The consequences are examined of setting $\hbar = 1$ and $c = 1$, while retaining the electron volt. The system of units thus defined is simple and practical for atomic and subatomic physics. A convention is also suggested which permits any quantity to be expressed by a number near unity. Trial teaching with such units is suggested. (auth)

37208 GAUGE INVARIANCE AND STRUCTURE OF THE CORRELATION FUNCTIONS OF A BOSE LIQUID. de Pasquale, F. (Universita, Rome). Ann. Phys. (N. Y.), 33: 381-399(July 1965).

Criteria are developed to construct correlation functions complying with the continuity equation and the longitudinal

sum rule, in the case of a homogeneous Bose liquid with condensation in the zero momentum state. The approach can be compared with methods previously used in the theory of superconductivity as the main idea consists in exploiting systematically a generalized Ward identity which follows from the invariance of the theory under infinitesimal gauge transformations. However, the structure of this identity, analyzed in terms of diagrams, turns out to be rather different from the structure of similar relationships already studied in the case of Fermi systems. A general conclusion following from the identity alone is that the correlation functions must be singular at $k = 0$. As a rule then the spectrum of density fluctuations will have no gap. It is also concluded that the theorem of Hugenholtz and Pines on the chemical potential and the spectrum of single-particle excitations is strictly connected with the generalized Ward identity and can actually be deduced from it. This leads to the identification of the $k = 0$ singularity of the propagator with the $k = 0$ singularity of the correlation functions. The usefulness of the method is illustrated by discussing specific approximations such as the Bogoliubov approximation and the nonlinear self-consistent scheme of Girardeau and Arnowitt. (auth)

37209 THE SCATTERING OF PLANE WAVES FROM PERIODIC SURFACES. Uretsky, J. L. (Argonne National Lab., Illinois and Univ. of California, San Diego). Ann. Phys. (N. Y.), 33: 400-427(July 1965).

The reflection of scalar plane waves from periodic surfaces (in two dimensions) is studied. Particular attention is devoted to the sinusoidal surface upon which the wave function vanishes. The formulation of the problem rests upon Green's theorem, and it is shown that in the sinusoidal case one is led to an infinite set of coupled algebraic equations. These are essentially different from the equations derived by Rayleigh in his original formulation of the problem. Numerical results are obtained, and the more interesting properties of the results are discussed. As a sidelight, it is shown that the matrix of reflection coefficients for an arbitrary periodic nonabsorbing surface has interesting symmetry properties reminiscent of the quantum-mechanical S-matrix. (auth)

37210 GENERATION OF VERY POWERFUL MAGNETIC FIELDS. Parkinson, D. H. Electron. Power, 11: 79-86(Mar. 1965).

Techniques for generating magnetic fields in excess of 100 kOe are presented. The three methods are discussed in detail: solenoids of conventional conductors (e.g., copper) which are liquid cooled to near ambient temperatures; conventional conductor solenoids cooled with cryogenic liquids; and superconducting solenoids cooled with liquid helium. Pulsed-field systems for fields in excess of 500 kOe are also discussed. (L.B.S.)

37211 ATOMIC POWER RESEARCH IN UNIVERSITIES. Oyama, Kyo (Ministry of Education, Japan). Genshiryoku Kogyo, 11: No. 4, 61-4(Apr. 1965). (In Japanese)

Nuclear research in Japanese universities is discussed. Seven tables give the overall progress at the various universities in Japan for 1964. Four of these tables are concerned with schools working on particle accelerators, neutron generators, critical facilities, and fusion research respectively. Total finding is given in another table. (TTT)

37212 VARIATIONAL PRINCIPLES FOR COMPRESSIBLE VISCOUS FLUID IN MAGNETOHYDRODYNAMICS. Sharma, N. K.; Sharma, S. R. (Univ. of Rajasthan, Jaipur, India). Indian J. Phys., 39: 25-32(Jan. 1965).

Variational principles with proper Lagrangian densities for the case of a magnetohydrodynamic viscous compressible fluid were used to derive momentum equations and the equations governing the magnetic field. As an illustration the case of a perfectly conducting plasma continuum was treated. (auth)

37213 THE SIGNIFICANCE OF THE MINIMUM DOPPLER DISPLACEMENT IN CANAL RAYS. Sitakumari, B. V. (Patna Women's College, India). Indian J. Phys., 39: 41-5(Jan. 1965).

Measurements of the gap of zero intensity which exists between the undisplaced line of H_α, H_β and H_γ and the Doppler band in pure hydrogen are presented when the current in discharge tube is kept constant. The gap width rises as the accelerating voltage is increased. The width shows two small maxima at 3 kv and 6 kv which are interpreted as due to relatively large numbers of H_{4+} and H_{3+} ions respectively. These findings are in accord with earlier measurements of the intensity maxima observed in the Doppler band. The gap width maxima for H_α, H_β and H_γ do not lie at the same accelerating voltage because an increase in the voltage is thought to be associated with a decrease in the width of the ion-energy distribution. Thus with increasing voltage, the gap width should increase more than linearly as has in fact been observed. (auth)

37214 ELECTRON VELOCITY DISTRIBUTION IN SLIGHTLY IONIZED ARGON WITH CROSSED ELECTRIC AND MAGNETIC FIELDS. Jain, D. C.; Nag Chaudhuri, B. D.; Das Gupta, B.; Bose, D. K.; Sen Gupta, S. N. (Saha Inst. of Nuclear Physics, Calcutta). Indian J. Phys., 39: 88-96(Feb. 1965).

A method of solving the Boltzmann equation for the distribution function of electrons in slightly ionized argon with crossed electric and magnetic fields is outlined using Golant's analytical approximations of the experimental data on the cross sections for elastic and inelastic collisions. The distribution function is obtained in the presence of an electric field of arbitrary frequency crossed with a constant magnetic field as well as in the presence of crossed d-c electric and magnetic fields. It was found from the plots of the electron distribution function that for a given E/p, the distribution with crossed d-c electric and magnetic fields contains more low-energy electrons than that with only d-c electric field, and that in a given transverse magnetic field, the electron distribution for a higher E/p is richer in higher-energy electrons than that for a lower value of E/p. (auth)

37215 HYDRODYNAMIC ANALYSIS OF NOISE IN A FINITE-TEMPERATURE ELECTRON BEAM. Hsieh, H. C. (Univ. of Michigan, Ann Arbor). J. Appl. Phys., 36: 2414-21(Aug. 1965).

On the basis of a small-signal, one-dimensional analysis, a set of basic macroscopic differential equations, governing the fluctuations in quantities such as the electron-beam temperature, the mean velocity, and the current density, was derived by taking moments of the Liouville equation with respect to the velocity variable. This set of differential equations expresses the conservations of charge, momentum, and energy, and is valid for an arbitrary amount of velocity spreading and includes the effect of heat conduction. A system of differential equations, governing the correlation among the fluctuations in the mean velocity, current density, and beam temperature, is also derived. The relationship among the various noise parameters along the electron beam is obtained in the form of a system of differential equations whose solution gives detailed information on the variation of the noisiness parameter along the beam. The solution of the system of differential equations thus derived is also discussed. (auth)

37216 FLUX-DENSITY PATTERNS OF GRAVITATIONALLY BOUND PARTICLES ABOUT A FINITE ATTRACTIVE CENTER. Hale, D. P.; Wright, J. J. (George C. Marshall Space Flight Center, Huntsville, Ala.). J. Geophys. Res., 70: 3007-15(July 1, 1965).

The results of an investigation of the characteristics of flux and density fields generated by the isotropic injection of bound particles into the gravitational field of a finite attractive center are presented. It is found that both flux and density maximums occur; that the density maximum always lies outside the flux maximum; and that the extremum values, for the distances of the flux and density maximums of bound particles from the attractive center, are $\frac{3}{2}$ and 2 radii of the finite center, respectively. When distances are measured in units of the center radius, and speeds in units of the "escape velocity" from the surface of the center, several interesting relations between the characteristics of surviving orbits can be easily developed and displayed, including the fraction of injected particles

that falls into surviving orbits as a function of the location of the point of injection and the magnitude of the injection velocity. (auth)

37217 MOBILITY OF MASS-ANALYZED H^+, H_3^+, AND H_5^+ IONS IN HYDROGEN GAS. Saporoschenko, M. (Washington Univ., St. Louis). Phys. Rev., 139: A349-51(July 19, 1965). (TID-21834)

The mobilities of the positive ions H^+, H_3^+, and H_5^+ in H_2 gas have been measured, using the "four-gauze" electrical shutter method. The ions have been identified mass-spectrometrically. Measurements were made over a range of E/p_0 (E = electric field intensity, p_0 = normalized pressure) from 5.5 to 100 v per cm × mm Hg and in a pressure range of from 0.5 to 1.6 mm Hg. The predominant ion is H_3^+. The mobility μ_0 corrected to 0°C for the H^+ ions was 14.4, for the H_3^+ ions 10.2 and for the H_5^+ ions 9.6 $cm^2/v \times sec$ at $E/p_0 = 10$ v/cm × mm Hg. With increasing E/p_0, the mobility of the H^+ ions decreases, that of the H_5^+ ions increases to a maximum of 14.7 cm^2/v sec at $E/p_0 = 60$ c/cm × mm Hg and then decreases, and that of the H_5^+ ions increases. (auth)

37218 MOBILITY OF MASS-ANALYZED N^+, N_2^+, N_3^+, AND N_4^+ IONS IN NITROGEN GAS. Saporoschenko, M. (Washington Univ., St. Louis). Phys. Rev., 139: A352-6 (July 19, 1965). (TID-21833)

Drift-velocity measurements as a function of E/p_0, the ratio of field intensity to normalized gas pressure, were obtained for positive ions N^+, N_2^+, N_3^+, and N_4^+ in nitrogen gas using the "four-gauze" electrical shutter method of Tyndall. Extrapolation of the low-field measurements to zero field yields the values of the mobility μ_0, corrected to 0°C: 2.54 ± 0.05, 1.70 ± 0.05, 1.90 ± 0.05, and 2.34 ± 0.05 cm^2/v sec for N^+, N_2^+, N_3^+, and N_4^+, respectively. The actual data were obtained at gas temperatures 28–32°C. The ions were identified mass-spectrometrically during the process of measurement of the drift velocities. Gas pressure in the dirft tube was in the 0.55–1.5 mm Hg range. Relative intensities of the four nitrogen ions were measured as functions of E/p_0. Approximate cross sections for formation of the secondary ions were also determined. The reversible reaction processes $N_2^+ + N_2 \rightarrow N_4^+$ and $N_4^+ + N_2 \rightarrow N_2^+ + 2N_2$ were observed experimentally. (auth)

37219 ENERGY BROADENING IN THE AUGER-TYPE NEUTRALIZATION OF SLOW IONS AT SOLID SURFACES. Hagstrum, H. D.; Takeishi, Y.; Pretzer, D. D. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 139: A526-38(July 19, 1965).

Recent improved measurements of kinetic-energy distributions of electrons ejected from metals and semiconductors by slow ions make it possible to examine the energy broadening inherent in the Auger neutralization process. Broadening, defined as the full width at half maximum of a convoluting Lorentzian function, is shown in all cases to vary linearly with ion velocity for ion energies less than 100 ev. Data for He^+, Ne^+, and Ar^+ ions and the crystal surfaces Ni(111), Ge(111), GaAs(111), GaAs($\bar{1}\bar{1}\bar{1}$), and GaAs(110) show that the magnitude of broadening depends both on ion and solid and varies by a factor of 5 among the ion-solid combinations studied. For 4-ev He^+ ions the broadenings are 0.96, 0.54, 0.37, 0.17, 0.31 ev for the surfaces listed above, respectively. The velocity-dependent broadening is the sum of components due to initial-state lifetime and nonadiabatic excitation of electrons from the filled band into states above the Fermi level from which they can participate in the Auger process. Other possible broadening components — those due to final-state lifetime, energy-level shifts in the atom near the surface, and variation of surface impact parameter — are shown to be small in the low-energy range. An analysis of earlier data for He^+ on Ge(111) at ion energies up to 1 kev indicates that the total transition rate does not increase appreciably above 100 ev, most likely as a result of the collapse of the barrier between the ion and the solid at higher ion energies. This analysis also shows that nonadiabatic excitation accounts for at most 1/3 and initial-state lifetime for at least 2/3 of the broadening at energies below 100 ev. The initial-state-lifetime broadening thus deduced shows the Auger neutralization process to be very rapid, having a transition rate for 4-ev He^+ ions on Ge(111) of about 5×10^{14} sec^{-1}. The magnitude deduced for broadening due to nonadiabatic excitation is shown to be in the range expected. Possible reasons for the variation with ion and solid are suggested also. (auth)

37220 TIME-REVERSIBLE MASTER EQUATIONS BY A DOUBLE INTEGRAL TRANSFORM METHOD. Pike, E. R. (Royal Radar Establishment, Great Malvern, Worcestershire, Eng.). Physica, 31: 461-74(Apr. 1965).

The same mathematical technique as is used in the double-time Green's function method in statistical physics is used to derive non-Markoffian equations in gain-loss form for master functions. The technique involves the use of a double integral transform in which a Fourier transform is followed by a Hilbert transform. The master functions can be used to follow the time development of the expectation value of any operator from any given pure or diagonal mixed state. In common with the methods of Swenson and Zwanzig, the equations are obtained without reordering of infinite-order perturbation series, and no coarse-graining or special properties of the system are required. (auth)

37221 ON THE T^3-LAW FOR THE SPECIFIC HEAT OF BOSE LIQUIDS. Goetze, W.; Wagner, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Physica, 31: 475-92(Apr. 1965).

Using the representation of the thermodynamical potential as a functional of the temperature-dependent Green's functions, it is shown that in the limit of temperature tending to zero, the specific heat of a Bose liquid has the same form as in a gas of noninteracting phonons. (auth)

37222 ASYMMETRY-EFFECTS IN MOLECULE-MOLECULE COLLISIONS. Reuss, J. (Katholieke Universiteit, Nijmegen, Netherlands). Physica, 31: 597-605 (Apr. 1965).

The effect of angular dependent terms in the intermolecular potential of colliding molecules is investigated in a first-order distorted-wave calculation. The final expression for the total elastic collision cross section is obtained in the approximation of Massey and Mohr. (auth)

37223 COHERENT INTENSITY DISTRIBUTIONS FROM BOSON STATISTICS. Troup, G. J. (Monash Univ., Clayton, Victoria, Australia). Proc. Phys. Soc. (London), 86: 39-43(July 1965).

The probability distributions of intensity for thermal and ideal laser beams are derived directly from the Bose-Einstein distribution for photons in phase space, using the correspondence principle. Thus, the approach of Kastler is shown to yield the same result for the intensity distribution for an ideal laser as the work of Mandel. (auth)

37224 RESONANCE TRANSITIONS OF WAVES IN THE PRESENCE OF SPLITTING. Baryshevskii, V. G.; Lyuboshitz, V. L.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 19-21(July 1965).

Translated from Yadern. Fiz., 1: 27-31(Jan. 1965).

Resonance transitions of waves of different types (neutrons, light, mesons(K)) in the presence of splitting and the corresponding periodic perturbation are considered. The complete analogy of these phenomena to the case of paramagnetic resonance is demonstrated. (auth)

37225 ON THE STRUCTURE OF BLAST WAVES IN INCOMPLETELY IONIZED GAS. Pidstrigach, T. S. (Gor'kii State Univ., USSR). Ukr. Fiz. Zh., 10: 601-9 (June 1965). (In Ukrainian)

The structure of blast waves in partially ionized gas was investigated. The system of differential equations obtained, describing the charge in electronic and ionic temperatures, as well as the degree of ionization and density of the gas behind the front of the iono-atomic jump, is subsequently

solved numerically on an electronic computer. The results obtained are discussed. Cases of blast waves of varying intensities are considered with various values of the radiation parameter γ. The behavior of the maximum of electronic temperature, density and other parameters is discussed in dependence on the velocity of the blast wave and various initial conditions. The conclusions are illustrated by curves. (auth)

37226 ON THE MECHANICS OF TWO-POINT CHARGES WITH REGARD TO RETARDATION. Schmutzer, Ernst (Universitat, Jena, Ger.). Z. Naturforsch., 20a: 647-9 (May 1965). (In German)

The mechanics of two charged mass points is developed by taking into account retardation effects. Especially the formula for the force between the two charges is deduced. (auth)

37227 SOME PROBLEMS OF RELATIVISTIC HYDRODYNAMICS OF RELAXING MEDIA. Zhumartbaev, M. T. (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). Zh. Eksperim. i Teor. Fiz., 48: 1646-55(June 1965). (In Russian)

A closed equation set for relaxation relativistic hydrodynamics is derived under the assumption that the nonequilibrium states which arise can be described thermodynamically. The two limiting cases (relativistic and ultrarelativistic) in which the relaxation process is conditioned on the one hand by the rate of the chemical reactions and on the other by the rate of pair creation and annihilation are considered. The propagation of small perturbations in a relaxing medium is studied. The limiting transition to equilibrium relativistic hydrodynamics is carried out for small relaxation times. The structure of a weak relativistic shock wave is considered by taking into account relaxation. The two-component relativistic hydrodynamic equations are extended to multicomponent systems and are applied to multiple production of particles. (auth)

37228 INFLUENCE OF FINITE CONDUCTIVITY ON PRODUCTION OF HIGH MAGNETIC FIELDS BY IMPLOSION OF CONDUCTING SHELLS. Bichenkov, E. I. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 6, 3-5(Nov.-Dec. 1964). (In Russian)

The use of fast compression of conducting shells with confined magnetic flux was proposed previously for achieving ultrastrong magnetic fields. A record magnetic-field intensity (14.3×10^6 G) was attained in experiments using this principle. The phenomena occurring during compression are usually considered in the approximation of infinite conductivity of the material of the shell (superconductor), not taking into account the diffusion of the field in the conductor, its heating, possible evaporation, and effects of these factors on changes in electric conductivity. A general statement of the problem is formulated, and the phenomena connected with the presence of finite conductivity are studied. The maximum field and the effective depth of penetration of the field are calculated in the approximation of constant conductivity, for the case of compression of a homogeneous magnetic field by two plane parallel surfaces moving toward each other with constant velocity. (tr-auth)

37229 ON THE STRUCTURE OF ELECTROMAGNETIC SHOCK FRONTS IN NONLINEAR TRANSMISSION LINES. Belyantsev, A. M.; Gaponov, A. V.; Freidman, G. I. (Gorkii Univ., USSR). Zh. Tekhn. Fiz., 35: 677-89 (Apr. 1965). (In Russian).

Stationary solutions of the telegraphic equation with nonlinear parameters are discussed in general terms. The system is specified by a pair of nonlinear functionals giving the linear densities of charge and flux in terms of the current and potential. Most attention is given to stationary shock waves (disturbances that propagate at constant velocity with unchanged form, but with different asymptotic values of the current far in front and far behind). Conditions are derived for the existence of shock waves in two-conductor transmission lines. Several simple specific cases, representative of general types of transmission line, are discussed in more detail; and the solutions are obtained. These include transmission lines with space dispersion (i.e., for which the defining functionals contain derivatives with respect to the coordinate measured along the transmission line), and lines exhibiting certain peculiarities that can be realized by the use of ferrites. (ATD)

37230 ON THE STRUCTURE OF SHOCK WAVES IN NONLINEAR TRANSMISSION LINES WITH DELAYED EXCITATION OF INTERNAL DEGREES OF FREEDOM. Belyantsev, A. M.; Gaponov, A. V.; Freidman, G. I. (Gorkii Univ., USSR). Zh. Tekhn. Fiz., 35: 690-704 (Apr. 1965). (In Russian)

Transmission lines for which the nonlinear functionals giving the charge and flux densities in flux densities in terms of the current and potential involve two very different time constants are discussed. Methods are developed for the approximate separate treatment of the slow and fast processes. It is shown that the approximate equations containing only the slow processes have discontinuous solutions corresponding to shock waves when and only when the phase space contains singular surfaces of a certain type. The important features of the discontinuous solutions can be determined from these singular surfaces, and the structure of the continuous shock wave can be subsequently calculated by including the fast processes. Several special cases are discussed in considerable detail. An oscillogram is presented of the shock front in a transmission line involving a saturating ferrite inductance and two RC shunt circuits with 1- and 20-μsec time constants; this oscillogram illustrates features of the calculated shock front structure. (ATD)

37231 DEVELOPMENT OF A SURFACE SPARK DISCHARGE CHANNEL. Daniel, E. V. Zh. Tekhn. Fiz., 35: 769-71(Apr. 1965). (In Russian)

It was previously found that the surface discharge channel on a titanium-containing ceramic with a dielectric constant of 150 is brighter than the corresponding free discharge in the same atmosphere. To investigate this phenomenon, surface discharges were photographed with a slotted mechanical scanning disk, and the discharge current and voltage were measured simultaneously. The time resolution was 4 μsec, and the radius of the discharge channel was measured to an accuracy of 25%. The discharge channel was scanned in two planes: one parallel to the surface of the dielectric and one perpendicular to it. The spark channel reached its maximum radius (of the order of a few millimeters) at the same time that the current reached its peak value. The channel was 50% larger in the direction parallel to the dielectric surface than in the direction perpendicular to it, and there was a dark space 0.2 mm thick between the dielectric surface and the discharge plasma. The radius of the spark channel for a free discharge of the same current and duration was calculated by the theory of Braginskiy and was found to be considerably larger. This accounts for the difference in brightness. The greater the initial rate of growth of the surface discharge channel, the higher the discharge potential. (ATD)

37232 MAGNETIC MOMENT OF A CHARGED PARTICLE ENTERING A UNIFORM LONGITUDINAL MAGNETIC FIELD. Khizhnyak, N. A. Zh. Tekhn. Fiz., 35: 827-32 (May 1965). (In Russian)

The magnetic moment (ratio of the transverse kinetic energy to the magnetic field strength) acquired by a charge particle entering the uniform region of an axially symmetric magnetic field is calculated. If the particle moves on the axis the magnetic moment remains zero; otherwise the magnetic moment depends on the distance of the particle in the field-free region from the symmetry axis, the velocity of the particle, the magnetic field strength in the uniform region, and the manner in which the longitudinal magnetic field strength rises from zero at large distances to its final uniform value. The calculations are performed by solving the equations of motion for simple assumed asymptotic forms of the magnetic field and joining the solutions obtained to WKB solutions for the region in which the field varies sufficiently smoothly. Some of the results derived in this way are known; others appear to be new. Since the extent to which longitudinal kinetic energy is transformed

into transverse depends on the distance of the particle from the symmetry axis, a beam of finite cross section of particles all having the same velocity will acquire a distribution of longitudinal velocities on entering a region containing a uniform longitudinal magnetic field. (ATD)

37233 MOTION OF A CHARGED PARTICLE IN AN AXIALLY SYMMETRIC ELECTROMAGNETIC FIELD WITH A MEDIAN PLANE. Yavor, S. Ya. (Leningrad Physico-Technical Inst.). Zh. Tekhn. Fiz., 35: 935-9 (May 1965). (In Russian)

The relativistic motion of a charged particle in a static axially symmetric electromagnetic field having a median plane with respect to which the electric field is symmetric and the magnetic field is antisymmetric is discussed. The calculations were undertaken because of the increasing interest in such fields in connection with the production and control of disk beams. The solution of the equations of motion of a particle moving in the median plane is reduced to a quadrature. This solution reduces in the nonrelativistic case to that given by Coggeshall (Phys. Rev., 70; 270(1946)). The first-order perturbation equation for the motion of a particle near the median plane is derived. When the time differentiation is eliminated, the resulting equation for the trajectory admits a separation of variables. It is found that a point source is imaged by a plane beam of a certain type in a point image. The solution of this trajectory equation for the case of the absence of a magnetic field is reduced to a quadrature. The condition for the achromaticity of the inclination to the radius vector of a median plane trajectory is derived. (ATD)

37234 ON THE DISSOCIATION OF MOLECULAR IONS DURING INTERACTION WITH A SOLID SURFACE. Molchanov, V. A.; Soshka, V. Zh. Tekhn. Fiz., 35: 963(May 1965). (In Russian)

The ions scattered at 10°, 15°, 20° and 28° by a polycrystalline copper target from a beam of 30 kev nitrogen ions incident on it at 5° were investigated. At the small scattering angles, nitrogen molecule ions were present, as well as singly and doubly charged atomic ions. As the scattering angle increased the relative number of molecule ions decreased, and at the largest scattering angle none were perceptible. This behavior is explained by the fact that large scattering angles correspond to small impact parameters: an ion that is scattered through a large angle approaches close to the nucleus of the scattering atom, which apparently leads to a large dissociation probability. (ATD)

37235 USE OF THE NORMAL WAVE METHOD FOR RECTANGULAR SEPTATE WAVEGUIDE CALCULATIONS. Didenko, A. N. Zh. Tekhn. Fiz., 35: 967-9(May 1965). (In Russian)

A normal wave method was previously used to derive the dispersion equation for a septate waveguide of circular section with infinitely thin septa. This method is employed to derive the dispersion equation for cophase LE waves in a rectangular septate waveguide. Dispersion equations for antiphase LE waves and LM waves can be similarly derived. The Hertz vector for the LE waves is expanded in a Fourier series, and Floquet's theorem is applied. Then a rather involved dispersion equation is written in the form of a doubly infinite series. It is asserted that this dispersion equation can be derived by rather cumbersome calculations exactly similar to those employed by Vladimirskiy in the circular case. This dispersion equation is somewhat simplified with the assumption that there are but few septa per wavelength, and a very simple dispersion equation is derived for the case in which the openings in the septa are small. Kovalenko has derived a similar equation by an integral equation method. (ATD)

37236 MOTION OF IDEAL CONDUCTING BODY IN INHOMOGENEOUS MAGNETIC FIELD. Mingalev, B. S. p.121-37 of "Elektrofizicheskaya Apparatura. Vypusk 3." Moscow, Atomizdat, 1965. (In Russian)

Legendre-polynomial expansions are derived of equations that describe the motion of an ideally conducting sphere, ring, prolate spheroid, and oblate spheroid from deep within a semi-infinite cylindrical solenoid to a point far from the end of the solenoid. The initial equations assume that the axis of symmetry of the conducting body coincides with the axis of the solenoid. Perturbation theory is used to calculate the effect of a shift of the body from the center of the solenoid, or if the axis of symmetry is deflected from the axis of the solenoid. The calculations show that a ring and oblate spheroid are more accelerated by the magnetic field than a prolate spheroid. (TTT)

37237 FIELD AND WAVE ELECTRODYNAMICS. Johnson, Curtis C. McGraw-Hill Physical and Quantum Electronics Series. New York, McGraw-Hill Book Co., 1965. 470p, $12.50.

A unified and comprehensive approach to electrodynamics on the graduate level is given. The basic electromagnetic laws and Maxwell's equations are reviewed, and the wave equation, potential functions, and conservation theorems are derived; mathematical techniques for boundary-value problems are also reviewed. Wave phenomena in bounded and unbounded systems are described, giving a detailed discussion of waveguides. Applications of the theory are discussed, including waveguide discontinuities, cavities, periodic slow-wave transmission systems, electromechanical waves on electron beams, coupled transmission systems, optics, plasma, and ferrites. (M.J.T.)

37238 THE USE OF ELECTRONIC COMPUTERS FOR THE ESTABLISHMENT OF RADIATIVE CORRECTION FORMULAS. Synakh, V. S. pp 575-7 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

Planned colliding beam experiments will attempt to check the applicability of quantum electrodynamics at small distances. The associated computations are very long and tedious and, consequently, appropriate programs have been developed. Coded expressions for the matrix elements, corresponding to appropriate Feynman diagrams, are introduced into the computer which, following the stored rules for operation with symbols computes the cross section. Existing programs remove brackets and reduce similar terms, in particular express scalar products through independent invariants of the process; express traces of gamma-matrices and a symbol through combinations of Kronecker deltas, vector components, and scalar products; contract dummy vector and tensor indices; contract over μ the $\gamma_\mu \ldots \gamma_\mu$-type of expressions following the usual rules; and carry out two-trace product transformations. In cases requiring integrations over virtual momenta, the machine would need rules for discriminating which are not programmed yet complicated integrals and reducing them to simpler integrations. (CFSTI)

37239 AN INVESTIGATION OF THE ONE-DIMENSIONAL MAGNETOGASDYNAMIC FLOW OF FINITE CONDUCTIVITY MEDIA. Bowman, Thomas Eugene. Thesis, Evanston, Ill., Northwestern Univ., 1964. 167p.

The steady, one-dimensional continuum flow of an electrically conducting gas through an electromagnetic field is studied. The gas is assumed to be a neutral plasma with constant electrical conductivity, and to obey the perfect gas equation of state. The basic equations are combined to give an algebraic equation relating the velocity and the magnetic field. After this relationship is derived, all of the flow parameters can be related to each other by simple algebraic equations. Dimensionless parameters are defined and used throughout. Plots are presented of various parameters as functions of Mach number for selected boundary values. An equation is derived relating velocity to distance. Although solution of this equation for given boundary conditions depends on a numerical integration, certain general characteristics are deduced. Sample curves are calculated and plotted. The case of zero electric field, where an explicit u-x relationship exists, is studied and compared. The phenomena of continuous transitions from supersonic to subsonic and from subsonic to supersonic flow are studied and shown not to exist. The assumption of zero viscosity is replaced by one of constant viscosity, and the resulting basic equations are written and combined. Whereas the basic equations (except the equation of state) are all first order differential equations in the case of zero viscosity,

the viscosity term makes the momentum equation second order, introducing an additional boundary condition. No algebraic relationship between u and B can be derived, but two simultaneous first order equations are obtained relating u, B, and x. If the viscosity is assumed zero and the thermal conductivity is allowed to be finite but constant, the equations are similar in form to those for finite viscosity, in this case the energy equation being the second order equation. The u-B relationship is different from either of those obtained before, and is dependent on the boundary values of u, B, and du/dx. Zero conductivity is a singular point in all of the equations. A computer was used to solve the finite viscosity and thermal conductivity equations for one set of boundary conditions. The results are plotted for various conductivities and viscosities. (A.G.W.)

37240 METHODS FOR TRACKING TRAJECTORIES OF DIPOLE MOMENT PARTICLES MOVING IN INHOMOGENEOUS FIELDS. Zhigarev, A. A.; Nikitina, T. F.; Strakhovskii, G. M. p.3-14 of "Fizicheskaya Elektronika. Vypusk 2." Moscow, Atomizdat, 1965. (In Russian).

An equation is derived mathematically which relates the potential and the potential gradient in a nonhomogeneous axially symmetrical field to the radius of the trajectory of a neutral particle moving in the field. The trajectory of the particle can thus be traced if the potential and the gradient are known. When equal-gradient lines were found by using an electrolytic bath and the results were combined with the grapho-analytical construction of the trajectories, the results were sufficiently precise for solving many problems in analysis of moving dipole particles in a nonhomogeneous electric field. When greater precision is required, the method is too time-consuming. Therefore a means was developed for automatically tracing the trajectory. The trajectograph used is a special calculating machine that operates continuously and gives the instantaneous radius of the trajectory curve. Diagrams of the equipment and examples of the curves obtained are given. (TTT)

37241 VOPROSY MAGNITNOI GIDRODINAMIKI. III. DOKLADY, PROCHITANNYE NA 3-M SOVESHCHANII PO TEORETICHESKOI I PRIKLADNOI MAGNITNOI GIDRODINAMIKE b.g. RIGE 2-7 IYULYA 1962 g. (Problems in Magnetohydrodynamics. III. Reports of the 3rd Conference on Theoretical and Applied Magnetohydrodynamics, Riga, Latvia, July 2-7, 1962). Filippov, M. V. (ed.). Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1963. 408p. (CONF-620703).

Forty four papers are included on conducting fluid flow, streamlining of solids in magnetic fields at Reynold's magnetic numbers considerably smaller than unity, and on applied hydrodynamics. (R.V.J.)

Accelerators

Refer also to abstracts 36829, 36927, and 36935.

37242 (AE-189) AN ELECTROMAGNET FOR PRECESSION OF THE POLARIZATION OF FAST NEUTRONS. Aspelund, O.; Bjoerkman, J.; Trumpy, G. (Aktiebolaget Atomenergi, Stockholm (Sweden)). May 1965. 29p. Dep. (mn).

The advantages of using a transverse magnetic field for precessing the polarization of fast neutrons are discussed. Design details of a powerful electromagnet supplying a transverse field of approximately 20 kG are given. Precession characteristics for polarized fast neutrons obtained at 50° (lab) from the $^{7}Li(p,n)^{7}Be$ reaction are reported, using elastic scattering at 42° (lab) off natural carbon as an analyzer. Correlation of the precession data with theoretical predictions presented elsewhere is made, and good agreement is found. (auth)

37243 (BNL-9209) NOTE ON THE NORMAL MODE TREATMENT OF BEAM CAVITY INTERACTIONS AND THE MODE WIDTH. Gluckstern, R. L. (Massachusetts Univ., Amherst). May 5, 1965. For Brookhaven National Lab., Upton, N. Y. Contract AT(30-2)-Gen-16. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The response of a resonant cavity to periodic beam pulses is considered, performing calculations on the model of a damped vibrating string which is struck repeatedly and periodically at its center. The equation of motion for the string is written, and solutions are found both in terms of the normal resonant modes and by treating the string as a driven oscillator. The relation between the standing-wave solution for the normal modes and the solution obtained by reflections of traveling waves is also considered. (M.J.T.)

37244 (CERN-65-17) A NEW FOCUSING SYSTEM CONSIDERABLY INCREASING THE ACTUAL PS-NEUTRINO BEAM FLUX DENSITY. Asner, A.; Iselin, Ch. (European Organization for Nuclear Research, Geneva (Switzerland)). May 17, 1965. 49p. Dep.(mn).

Two variants of a new focusing system are described which will both yield a considerably higher neutrino flux density than the actual layout with the magnetic horn. The proposed variant consists of the actual 300 kamp magnetic horn with a long 45 cm copper target, and a V-shaped, at maximum 5m long, 400 kamp reflector placed at 14.5 m from the origin of the focusing system. Results are reported. (M.O.W.)

37245 (FSD/ING-10) SOC PARAMETERS BY COST MINIMIZATION. Lee-Whiting, G. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1965. 105p. (AECL-2267) Dep.; $2.00(AECL)

The interrelation of the more important parameters of a planar separated-orbit cyclotron (SOC) is discussed. A cost-minimizing procedure is developed for finding optimum values for many of these parameters. The resonant cavities of the SOC are assumed to be rectangular parallelepipeds, and the magnets are of the design suggested by Hudson and Lord. Among the parameters optimized are number of cavities, harmonic number, number of turns, magnet dimensions, and the voltage, dimensions and radial position of a cavity. The minimized cost consists of the sum of the more important capital and running charges which are deemed to depend significantly on the parameters to be determined; costs proportional to the beam power are not included. The procedure was coded for the CDC G-20 computer, and was used to study the dependence of cost and of values of the optimized parameters upon certain other parameters -e.g. frequency, final energy of the projectile, staging energy for a two-stage SOC. (auth)

37246 (NIRL/R/85) THE HARWELL VARIABLE ENERGY CYCLOTRON. Lawson, J. D. (National Inst. for Research Nuclear Science, Chilton (England). Rutherford High Energy Lab.). Mar. 1965. 24p. (CONF-650437-1). Dep. mn; BIS, $0.70; HMSO, 3s. 6d.

From Cyclotron Colloquim, Eindhoven, Netherlands.

A description is given of the Variable Energy Cyclotron being built for the AERE. This cyclotron will be used mainly for studies in radio- and radiation chemistry, metallurgy, and solid state physics. The cyclotron is a 3-ridge A.V.F. machine, with 70-in. diameter pole and maximum central field of 17 kg. A single dee is fed by an amplifier and coaxial line resonator, and up to 100 kv peak dee volts will be obtainable. The frequency can be varied from 7.6 to 23 mc, and studies of harmonic operation were made so that particles can be accelerated over a wide range of energy and charge-to-mass ratio. The top energy will be about 78 N^2/A Mev (where N = ion charge and A = atomic weight) except that protons will be limited to 50 Mev; the lower energy limitation is not so well defined. In order to facilitate the acceleration of heavy ions, source development was undertaken, and good pumping was provided. Probes at 120° intervals were built in as a permanent feature, so that setting up under various operating conditions can be achieved quickly. An extraction and beam handling system was designed, which will enable the beam to be transported into one of seven positions, situated in three independent shielded target rooms. (auth)

37247 (ORNL-3778(p.83-4)) METHOD FOR OBTAINING BURSTS OF POLARIZED NEUTRONS OF ENERGY 10-700 kev. Dabbs, J. W. T.; Harvey, J. A. (Oak Ridge National Lab., Tenn.).

Polarization by the use of the right-left asymmetry in scattering from He, together with moderation by graphite, appears to be possible at the proposed linac. (auth)

37248 (ORNL-3800(p.58-79)) THE OAK RIDGE ISOCHRONOUS CYCLOTRON. (Oak Ridge National Lab., Tenn.).

The operations, maintenance, and modifications of ORIC are described, as is the experimental program. (T.F.H.)

37249 (ORNL-3800(p.80-103)) ADVANCED ACCELERATOR DEVELOPMENT. Martin, J. A.; Livingston, R. S.; Fulmer, C. B.; and others (Oak Ridge National Lab., Tenn.).

Several SOC (Separated Orbit Cyclotron) concepts are described for producing beams having energies up to 800 Mev. Analyses are presented of the stability and tolerances, magnet requirements, r-f cavities, r-f power amplifier systems, mechanical design, facility plans, and residual radiation distributions for SOC's. (T.F.H.)

37250 (ORNL-TM-1082) RECENT PROGRESS ON THE SEPARATED ORBIT CYCLOTRON. (Oak Ridge National Lab., Tenn.). June 1965. W-7405-eng-26. 30p. Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

The general characteristics, the accelerating system and magnet structure, and the stability and tolerance of the separated orbit cyclotron are presented in three papers. Abstracts were prepared for each paper. (M.O.W.)

For abstracts of individual papers see: 37251, 37252, and 37253.

37251 (ORNL-TM-1082, pp 1-9) GENERAL CHARACTERISTICS OF THE SEPARATED ORBIT CYCLOTRON. Livingston, R. S.; Hudson, E. D.; Lord, R. S.; Mann, J. E.; Mosko, S. W.; Richardson, E. G. Jr.; Worsham, R. E.; Ziegler, N. F. (Oak Ridge National Lab., Tenn). (CONF-758-27).

From American Physical Society Meeting, New York.

The Separated Orbit Cyclotron is described. The major specifications and cost estimates of operation are given. Field requirements for double mode acceleration of proton, deuterons, and alpha particles are presented. The conditions for accelerating ions on various modes with seven r-f cavities are included. (M.O.W.)

37252 (ORNL-TM-1082, pp 10-17) THE ACCELERATING SYSTEM AND MAGNET STRUCTURE OF THE SEPARATED ORBIT CYCLOTRON. Lord, R. S.; Hudson, E. D.; Martin, J. A.; Ziegler, N. F. (Oak Ridge National Lab., Tenn.). (CONF-758-28).

From American Physical Society Meeting, New York.

The r-f cavity and magnetic concepts now under development are discussed. The basis of the discussion is the 200-800 Mev stage of an 800 Mev proton accelerator. (M.O.W.)

37253 (ORNL-TM-1082, pp 18-25) STABILITY AND TOLERANCES OF THE SEPARATED ORBIT CYCLOTRON. Worsham, R. E. (Oak Ridge National Lab., Tenn.). (CONF-758-29).

From American Physical Society Meeting, New York.

The physical arrangement of the cavities and magnets are discussed. Properties of the normal and extraction sectors are discussed. A stability diagram for a sector at 200 Mev is presented. The types of errors which can occur in magnet and their sensitivity are discussed. (M.O.W.)

37254 (UCRL-16000(Vols. I and II)) 200 Bev ACCELERATOR DESIGN STUDY. (Lawrence Radiation Lab., Univ. of California, [Berkeley]). June 1965. Contract W-7405-eng-48. 843p. Dep. mn; CFSTI, $10.25 cy, $3.75 mn.

The results of a complete preliminary design study and detailed cost estimates for the proposed 200-Bev strong-focusing proton synchrotron are reported. The study includes the accelerator design, its physical plant, the associated experimental areas, the support facilities, and estimation of the operating staff and budgets. The accelerator is comprised of a 750-kev preinjector, a 200-Mev linear accelerator, an 8-Bev injector synchrotron, and a 200-Bev main synchrotron. The basic arrangement plans of the accelerator at two site examples are shown. An investigation was also made of the differences in problems encountered at the two sites chosen for their different geological and foundation properties. The criteria for site evaluation were developed, and are listed and discussed. A time schedule for construction of the facility was developed, and a time table is presented for a particular site example. A set of drawings is included. (L.B.S.)

37255 (AEC-tr-6581) ANALYSIS OF THE RESULTS OF GEODETIC MEASUREMENTS ON THE FOUNDATION OF THE ELECTROMAGNET FOR THE 7-Gev ACCELERATOR AT THE INSTITUTE OF THEORETICAL AND EXPERIMENTAL PHYSICS (ITEF). Porubai, N. I.; Sivkov, Yu. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translated from report N-251. 1964. 41p. Dep.(mn); $2.00(cy), 1(mn) CFSTI; $4.60(fs), $1.43(mf).

It is concluded that the deviation of the orbit of the proton beam owing to deformation of the foundations and displacements of the pole pieces of the electromagnet of the ITEF proton synchrotron does not exceed 5 mm. The conclusion is based on geodetic measurements and analyses. (T.F.H.)

37256 (SLAC-Trans-16) CALCULATIONS OF PULSED MAGNETIC-FIELD COILS. Barkov, L. M.; Ogurtsov, V. V.; Khakimov, S. Kh. (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated by T. Watt (Stanford Linear Accelerator Center, Stanford Univ., Calif.), from report IAE-744. 1964. 62p. Dep.(mn); $3.00(cy), 2(mn) CFSTI; $6.60(fs), $2.06(mf) JCL.

Methods for the calculation of pulsed magnetic-field coils are considered. Magnetic field distributions, current density, evolution of heat, and mechanical stresses in the coils are calculated. Conditions of the applicability of the considered methods of computation are discussed. Forces acting on inter-turn insulation are calculated on the basis of measured values of the magnetic fields within the body of the coil. (auth)

37257 PHASE GROUPING OF CHARGED PARTICLE BEAMS DURING CAPTURE IN ACCELERATION PROCESS IN THE JINR SYNCHROPHASATRON. Kazanskii, G. S.; Mikhailov, A. I.; Rubin, N. B.; Tsarenkov, A. P. At. Energ. (USSR), 18: 555-9(June 1965). (In Russian)

A method is suggested for increasing the effectiveness of beam-particle capture by means of coupling the high-frequency acceleration field and phase-grouping of charged particles in the azimuthal direction. The frequency of accelerating field varies with the orbit turn in quasi-betatron operation. The results showed a 30% increase of particle capture in a synchrophasatron. (tr-auth)

37258 A 10-Mev WAVEGUIDE SYNCHROTRON. Vorob'ev, A. A.; Didenko, A. N.; Lisitsyn, A. I.; Morozov, B. N.; Potekhin, Yu. I.; Salivon, L. G.; Filatova, R. M. At. Energ. (USSR), 18: 633-4(June 1965).

Descriptions are given of the performance of a 10-Mev waveguide synchrotron with an accelerating system bent into a ring-shaped rectangular cross section waveguide diaphragmed along the external wall with the static wave $H_{0,18}$ type excited in the waveguide at $\pi/2$ oscillations. The rate of the $H_{0,18}$ wave is 13 cm. The preliminary electron acceleration injected by Kerst Cannon at 300 kev accelerates electrons in betatron operation to 3 Mev which are in turn accelerated to 10 Mev by high-frequency generator. The electromagnet is supplied by alternating current with the frequency of 50 cps. The oscillogram is given of the acceleration control showing the betatron operation, switching in of the high-frequency field, and capture and acceleration of electrons in the synchrotron. (R.V.J.)

37259 PASSAGE THROUGH THE CRITICAL ENERGY IN ACCELERATOR WITH AUTOMATIC CONTROL. Zhil'kov, E. A. At. Energ. (USSR), 18: 634-6(June 1965).

The influence of the automatic control system on the small size particle cluster motion through the critical

energy in a strong-focusing accelerator was studied using linearized equations for moments describing the cluster in the critical energy approximation. The small phase oscillations of the cluster center are described by the equation system: $d\Delta E/dt = -(eV_0\omega_s \sin\varphi/2\pi)\eta$; $d\eta/dt = \omega_0[K(t) + (\gamma^2/\gamma^2-1)\beta_\lambda]\Delta E/E_s + \omega_0\beta_\eta\eta + \delta$, where β_η and β_η are real coefficients of the inverse coupling circuit according to the pulse $\lambda = \Delta p/p$ and phase $\eta = \varphi - \varphi_s$ respectively; the δ takes into account the effect of external perturbations. The calculations indicated that the automatic system changed the character of the phase motion. However, the analysis of the center of cluster motion did not indicate that the accelerating field phase changed during its passage through the critical energy. It was shown that in the linear approximation the automatic control system did not affect the size of the cluster. The developed expression revealed that the cluster stability before and after the passage at $|\beta| > 1$ can be achieved only by automatic control system along the β_λ and β_η. The results hold good only for small size clusters in a linear approximation. (R.V.J.)

37260 PARTICLE LOSSES INDUCED BY THE PASSAGE OF NON-LINEAR RESONANCES IN ACCELERATORS AND STORAGE ELEMENTS. Kolomenskii, A. A. At. Energ. (USSR), 18: 636-8(June 1965).

An analysis was made of particle losses in strong-focusing large proton storage systems induced by the motion of non-linear resonances. Characteristical for cyclic accelerators and storage systems dangerous resonance are determined by $q_x\nu_x + q_z\nu_z = m$ (q_x, q_z, m are integers), (where ν_x and ν_z are the frequencies of radical and vertical betatron oscillations expressed in units of rotation frequency ω), The order of the resonance k was determined by $k = |q_x| + |q_z|$. It was assumed that the working point ν_1, ν_2 on the stability diagram does not approach the boundary of the cells determined by linear resonance bands ($k \leq 2$). This cell is intersected by non-linear resonance bands ($k > 2$) induced by magnetic field perturbations. The effects of these resonances are ordinarily very dangerous because a non-stationary working point is not compensated by a non-linear shift of frequency oscillations. In order to reduce the losses due to the resonance intersection it is necessary to reduce the perturbation oscillations in the magnetic field and to reduce the dependence of ν on the pulse p. (R.V.J.)

37261 SOME ENGINEERING PROBLEMS OF THE PROTON SYNCHROTRON NIMROD. Bowles, P. Electron. Power, 11: 155-9(May 1965).

A brief description is given of the Nimrod proton synchrotron, and of the interrelations that exist between the design aspects of the principle components. Examples are presented of mechanical engineering problems associated with the electromagnet, production of sectors of uniform quality, control of heating and cooling, structural stability, and measuring height and tilt. (L.B.S.)

37262 ELECTROSTATIC GENERATORS. Felici, N. J. Electron. Power, 11: 169-71(May 1965).

The principles of electrostatic generators are discussed and a comparison is made with electromagnetic machines. Some features of electrostatic generation, which are useful for many low-power, high-voltage applications requiring smooth direct current, are discussed. Two approaches to future progress and eventual acceptance of electrostatic generation in high-power sources for bulk-energy conversion are presented: vacuum-insulated variable-capacitance generators with optimum utilization of volume and high speed of rotation; and liquid-insulated cylindrical machines with exceptionally high output per unit area owing to high gap permittivity. (L.B.S.)

37263 THE FIRST NATIONAL PARTICLE ACCELERATOR CONFERENCE, WASHINGTON, D. C., MARCH 10-12, 1965. IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 1-1073(June 1965). (CONF-650306).

One-hundred-ninety-five papers are included; separate abstracts were prepared for 136. Fifty-nine papers were previously abstracted for NSA, see abstracts 19: 18635, 20095, 20204, 20326, 20718, 20719, 20720, 20723, 20724, 20725, 20726, 20727, 20728, 20731, 20732, 20733, 20734, 20735, 20737, 20915, 23210, 23211, 23940, 25090, 25091, 25092, 25093, 25094, 25095, 25096, 25097, 25098, 25100, 25101, 26963, 26964, 26973, 26974, 27022, 27024, 27026, 27027, 27028, 27370, 28934, 28935, 28936, 28955, 28956, 28957, 28958, 28964, 28965, 30875, 30876, 30882, 30883, 30885, and 30889. (L.B.S.)

For abstracts of individual papers see: 37264, 37265, 37266, 37267, 37268, 37269, 37270, 37271, 37272, 37273, 37274, 37275, 37276, 37277, 37278, 37279, 37280, 37281, 37282, 37283, 37284, 37285, 37286, 37287, 37288, 37289, 37290, 37291, 37292, 37293, 37294, 37295, 37296, 37297, 37298, 37299, 37300, 37301, 37302, 37303, 37304, 37305, 37306, 37307, 37308, 37309, 37310, 37311, 37312, 37313, 37314, 37315, 37316, 37317, 37318, 37319, 37320, 37321, 37322, 37323, 37324, 37325, 37326, 37327, 37328, 37329, 37330, 37331, 37332, 37333, 37334, 37335, 37336, 37337, 37338, 37339, 37340, 37341, 37342, 37343, 37344, 37345, 37346, 37347, 37348, 37349, 37350, 37351, 37352, 37353, 37354, 37355, 37356, 37357, 37358, 37359, 37360, 37361, 37362, 37363, 37364, 37365, 37366, 37367, 37368, 37369, 37370, 37371, 37372, 37373, 37374, 37375, 37376, 37377, 37378, 37379, 37380, 37381, 37382, 37383, 37384, 37385, 37386, 37387, 37388, 37389, 37390, 37391, 37392, 37393, 37394, 37395, 37396, 37397, 37463, and 37742.

37264 COMPUTER CONTROL OF HIGH ENERGY ACCELERATORS. Lewis, Lloyd G. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 1-8(June 1965).

The complexity of high energy accelerators has increased to the point where digital control techniques offer significant advantages. The basic techniques and equipment have been developed over the last ten years for use in chemical and steel plants. Some of these techniques can be used in modified form on high energy accelerators. The amount of time required for analog-to-digital conversion and for computer input-output operations limits computers to supervisory type control. The relatively slow output rates from the computer, in combination with the precise timing requirements of the synchrotron, indicate that a special buffer is required between the computer and the synchrotron. This buffer should be able to store and execute the instructions necessary to adjust all variables (magnitude and time) that are under computer control. Present control computers are so well perfected that most of the development effort goes into suitable sensing equipment and into computer programs. Injector alignment, analysis of coasting beam, control of tune, and control of characteristics of the beam to each of several experiments are some of the functions that appear to be realizable. (auth)

37265 LINAC ALIGNMENT TECHNIQUES. Herrmannsfeldt, W. B. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 9-18(June 1965).

Techniques of aligning linear accelerators are discussed with specific reference to the alignment system of the two-mile accelerator. This system uses a three-point method by which a point which is to be aligned is brought into coincidence with the line as defined by its end points. The end points are a laser and a photo-electric detector. A rectangular Fresnel lens is located at each point to be aligned to define the third point. (auth)

37266 ZGS FEEDBACK SYSTEM. Dinkel, J. A.; Daniels, R. E.; Das, S. K.; Martin, J H.; Simanton, J. R.; Teng, L. C. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 27-30(June 1965).

The beam phase damping techniques employed in the ZGS was investigated. Phase oscillation frequencies were measured at various times during acceleration. Response data taken on all systems involved with phase and radial position measurement were used to calculate the phase and radial position responses. These results compare favorably with responses measured on the ZGS with accelerated beam. (auth)

37267 ELECTRONIC INSTRUMENTATION AND CONTROL AT THE PRINCETON-PENNSYLVANIA ACCELERATOR. Riedel, J.; Droege, T.; Kang, C. L.; Kirchgessner, J. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 31-5(June 1965).

Brief descriptions are given of the electronic and control features of the digital B integrator, clock pulses, pedestal generators, self-correcting function generators, precision frequency sampling, magnet regulators, and beam separators for the Princeton-Pennsylvania proton synchrotron. (L.B.S.)

37268 MULTIPLEX CONTROL AND MONITORING OF A LARGE ACCELERATOR. Littauer, Raphael (Cornell Univ., Ithaca, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 36-8(June 1965).

A time-sharing pulse multiplex system is described which will perform most of the control and monitoring functions for the Cornell 10-Bev electron synchrotron. Beyond the reduction in the number of cable runs and the more compact presentation of data at the control desk made possible by this system, the control language is also suited for communication with a computer. Operation of the accelerator under computer control is envisaged. (auth)

37269 PRECISION PHASE ADJUSTMENT OF A LINEAR ACCELERATOR HIGH POWER WAVEGUIDE FEED NETWORK. Alvarez, R.; Borghi, R.; Weaver J. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 39-43(June 1965).

Each klystron of the SLAC accelerator feeds four consecutive 10-foot accelerator sections through approximately 25 feet of earth shielding. The high power waveguide network which divides and guides the power to the four sections is adjusted so that the rf waves traveling within the accelerator sections are, at the end of each section, phased within two degrees of an ideal wave traveling at the velocity of light. A modulated reflection technique is used to compare the electrical phase length from a single input through the four arms of the network during adjustment. The inclusion of the previously tuned accelerator sections in the network allows the total phase error to be minimized if careful control is exercised over the section temperatures. The measuring system, the reflection modulators, and the possible errors involved are discussed. (auth)

37270 INSTRUMENTATION AND CONTROLS FOR THE STANFORD LINEAR ACCELERATOR. Johnston, Lawrence H. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 44-7 (June 1965).

The philosophy of an accelerator instrumentation system, and techniques which have been worked out for handling the various remote sensory and control functions required for proper operation of the accelerator are discussed. (auth)

37271 THE NRL CYCLOTRON BEAM CONTROL AND HANDLING SYSTEM. Bond, C. D.; Reich, H. A.; McWalters, P. F.; Eisele, J. A. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 54-7(June 1965).

The beam handling apparatus and its associated remote control arrangements are described for the NRL Cyclotron Beam Transport System. The need for reducing duplication of controls and power supplies for such a multi-beam-path facility resulted in the development of a rapid master selector system which can be programmed to accommodate the different beam path requirements. All ion optics and beam sensing components along any particular beam path can be activated from a single selector panel, and then individually controlled. The beam transport display, vacuum control display, and control console, are laid out in graphic form wherever feasible in an effort to present readout and control information concisely and continuously. Precision, versatility, modular construction, and ease of maintenance guided the mechanical and electrical design criteria. Design details and prototypes of beam stops, scanners, viewers, collimators, probes, and pumping stations, are discussed. (auth)

37272 A SYNCHRONIZATION PULSE FOR THE PRINCETON-PENNSYLVANIA ACCELERATOR. Awschalom, M.; Iŝaila, M. V.; Shoemaker, F. C. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 74-5(June 1965).

The basic synchronizing pulse in the Princeton-Pennsylvania Accelerator, tying the injection pulse and the r-f to the magnetic field, is derived from the total current flowing through one of the accelerator magnets. This pulse is generated in a biased toroidal coil wound on a supermalloy core, by the magnetic field H(t) created by the magnet current in a coaxial conductor. This method has provided a synchronization signal pulse with excellent long term stability and very little time-jitter. Part of the time-jitter may be attributed to the variations of dH/dt at the time of the reversal of the magnetization of the core due to variations of I_{min} in the magnets. A method was developed to effectively cancel out the dH/dt effect in the supermalloy core. (auth)

37273 GRID-CONTROLLED POWER TUBES IN PARTICLE-ACCELERATOR APPLICATIONS. Hoover, M. V. (Radio Corp. of America, Lancaster, Penn.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 76-85(June 1965).

Typical illustrative examples are cited for the use of grid-controlled power tubes in the various classes of particle accelerators, e.g., cyclotrons, synchrocyclotrons, proton synchrotrons, electron synchrotrons, and linear accelerators. A state-of-the-art review of triode and tetrode power-tube technology is presented, together with some apparent trends in the design and development of new tubes. The use of triodes and tetrodes with integral cavity-resonators enhances the feasibility of their use at increasingly higher frequencies and/or power levels. In addition to their use as radiofrequency generators in particle accelerators, grid-controlled power tubes are also applicable as pulse modulators and amplitude regulators. The unique advantages of gridded power tubes for particle accelerators are discussed. (auth)

37274 HIGH POWER KLYSTRONS. Lebacqz, J. V. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 86-95(June 1965).

The evolution of high power klystrons and their applications in supplying r–f energy for linear accelerators are reviewed. Other types of possible r–f sources were considered for SLAC, and the reasons for the selection of klystrons are given. A brief review of klystron types in use for various accelerators is also given, but the emphasis is on the work done by Stanford and its subcontractors in developing klystrons capable of achieving peak powers in excess of 20 Mw and average powers of 20 kw for use with the two-mile Stanford linear accelerator. (auth)

37275 A COMPARISON OF TRIODES AND KLYSTRONS FOR PARTICLE ACCELERATOR APPLICATIONS. Morris, A. J.; Martin-Vegue, C. A. (Energy Systems, Inc., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 96-109(June 1965).

In the frequency range between 200 and 1200 mcs, it is possible to use either klystrons or triodes for particle accelerator applications. The bases of choice between these tube types are analyzed from a systems point of view. The development status, initial and operating costs, reliability, system complexity, and all pertinent technical factors are treated. The tentative specifications of the proton linear accelerator r–f system proposed by Los Alamos are used as a basis for comparison, and the conclusions reached on this system are extrapolated to higher and lower frequencies. It is concluded that either triodes or klystrons can be used in most, if not all, applications and that in almost every significant respect, in the frequency range considered, the klystron system is superior to the triode system. (auth)

37276 ZERO GRADIENT SYNCHROTRON RF SYSTEM. Klaisner, L. A.; Daniels, R.; deParry, T.; Martin, J.; Mc-

Donnell, J.; Simanton, J.; Stephenson, J.; Stockdale, T.; Turner, C.; Winje, R. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 133-7(June 1965).

The design and construction of the radiofrequency accelerating system of the Argonne ZGS are discussed. The system requirements, the equipment that has been developed to fulfill these requirements, and the present performance of the system are described. (L.B.S.)

37277 THE AMPLITRON AS A HIGH POWER, EFFICIENT, RF POWER SOURCE FOR LONG PULSE, HIGH RESOLUTION LINEAR ACCELERATORS. Ruden, Thomas E. (Raytheon Co., Burlington, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 169-73(June 1965).

An economical systems approach directed toward the generation of long pulse, high average r−f power for linear accelerators can be achieved via the use of the Amplitron, an efficient crossed-field amplifier of high phase stability, in conjunction with a newly developed Machlett switch tube. A 3 Gc Amplitron to provide 3 mw peak power (150 kw average power) at 50 μs pulse lengths is described. A cold secondary emission cathode of platinum is employed which enables a tube life of 10,000 hours to be guaranteed. Operating at a low anode voltage of 54 kv, the Amplitron is compatible with the ML-8549 super power switch tube; a hard tube modulator is thus employed. A single triode will switch a minimum of 10 Amplitrons. Not only is the cost of capital equipment drastically reduced by this unique, highly efficient combination of Amplitron-switch tube, but in addition, with grid control a fine adjustment on output power relative to the monitored beam energy can be made to achieve exceptionally high energy resolution in the beam. (auth)

37278 A CYCLOTRON POWER-AMPLIFIER RF SYSTEM USING A 4CW50,000/8350 TETRODE. Osterlund, Jon W ; Smythe, Rodman (Univ. of Colorado, Boulder). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 174-9(June 1965).

A major change in the power amplifier and other changes in the control circuits of the radio frequency system of the University of Colorado 52″ cyclotron are described. Operating experience with the system is reported, and some of the parameters of the system are tabulated. (L.B.S.)

37279 WINDOW MATERIALS DESIGN AND PROPERTIES FOR USE IN HIGH POWER KLYSTRONS. Bierce, R. W.; Fowkes, W. R.; Jasberg, J. H. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 180-4(June 1965).

This paper discusses the design of and material for klystron output windows to be used on the Stanford 20-Bev linear accelerator. Alternative window geometries are considered in view of the requirements of the SLAC application. Criteria for choice of window material are presented along with physical properties of several dielectric materials, and results of experimental evaluations of various window materials are described. The necessity for, and effectiveness of, techniques for reducing multipactor are discussed. Reasons are given for the choice of the present SLAC klystron window. (auth)

37280 ANALYSIS OF RESONANT RADIO-FREQUENCY COUPLING SYSTEMS. Hendry, George O. (William M. Brobeck and Associates, Berkeley, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 191-4(June 1965).

Resonant coupling circuits useful in coupling r−f energy to cyclotron r−f resonators are considered. In one circuit, the anode of the r−f power tube is connected directly to the coupling loop. In another, a length of transmission line connects the anode to the coupling loop. Inductive (loop) coupling is assumed. With slight modification, the expressions derived apply equally well to capacitively coupled circuits. (auth)

37281 ACCURATE FIELD LEVEL AND PHASE CONTROL AND MONITORING FOR A PROTON LINEAR ACCELERATOR. Batchelor, K.; Gallagher-Daggitt, G. (Rutherford High Energy Lab., Chilton, Berks, Eng.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 195-200(June 1965).

A method of setting up and maintaining the correct phase and amplitude of the fields in the three accelerating cavities of the Rutherford Laboratory proton linear accelerator is described. A system using a shunt regulator valve to control the field amplitude during the 200 μsec beam pulse is presented and the effect of source impedance on the build up of power in an accelerating cavity discussed. Measurements taken on the proton linear accelerator are given for comparison with the theoretical results. (auth)

37282 HIGH POWER UHF COMPONENTS FOR DESY. Schaffer, G. (Deutsches Elektronen-Synchrotron DESY, Hamburg). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 208-12(June 1965).

Data are presented on the design and performance of high power uhf components used at DESY to accelerate electrons up to 6.5 Bev. Provisions and additional requirements for an extension of the beam energy up to 7.5 or 8 Bev are briefly described. (auth)

37283 SOME NEW RADIO FREQUENCY ACCELERATING STRUCTURES. Giordano, S. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 213-16(June 1965). (BNL-8951)

A multiply periodic radiofrequency structure operating as a standing wave $\pi/2$-mode accelerator is discussed and compared with symmetrical structures such as the cloverleaf, plotted-iris, and disc-loaded waveguide. (L.B.S.)

37284 RF SYSTEM OF THE GRENOBLE 85-INCH CYCLOTRON. Leboutet, H.; Jean, R.; Schnuriger, J. C. (CSF, France). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 217-21(June 1965).

The Grenoble r−f system has been designed to provide the possibility of varying the frequency and energy of the cyclotron in operation. Two dees are used with two resonant cavities of a new conception. Tuning is achieved by displacement of a panel without sliding contacts. The r−f energy is supplied by two power amplifiers built on top of these cavities and driven by a stable frequency synthesizer followed by a wide band distributed amplifier. Automatic tuning and voltage stabilization will be provided for ease of operation. (auth)

37285 TRIODES AND KLYSTRONS AT ULTRA-HIGH FREQUENCY. Lundstrom, Oscar C. (Varian Associates, Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 222-6(June 1965).

Triodes and klystrons are compared, especially with respect to the internal voltage gradients and emission current densities necessary in designs to serve as r−f power sources for the high intensity, high energy proton linear accelerators now in planning at Los Alamos and at Brookhaven. (auth)

37286 DYNAMITRONS OF THE FUTURE. Cleland, Marshall R.; Farrell, Paul (Radiation Dynamics, Inc., Westbury, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl Sci., NS-12: No. 3, 227-34(June 1965).

A description of the Dynamitron high-current accelerator is given, illustrated with a photograph of a 3.0 Mv unit. Simplified circuit diagrams of the rectifier cascade are presented and performance data are compared with formulas for internal impedance and power consumption. Brief descriptions of the ion source and the beam tube are also given. Possibilities for future development of the accelerator and accessories are discussed. These include higher voltage, higher beam current, terminal pumping, terminal mass analysis, nanosecond beam pulsing, high intensity pulsing, high energy negative ion production and dual purpose tandem accelerators. (auth)

37287 TANDEM ACCELERATORS OF THE FUTURE. Burrill, E. Alfred (High Voltage Engineering Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 235-41(June 1965).

From the impetus of world-wide acceptance, the tandem-accelerator technology is continuing to advance rapidly. In a broadly based group of research and development programs at HVEC, the following areas are already producing important results for future tandem performance and design: intense beams of positive and negative ions, as well as neutral particles; powerful sources of high-voltage direct current; injection studies for light and heavy ions; efficient charge-changing techniques and systems; high transmission of ion beams through the tandem; improved voltage insulation in vacuum and high-pressure gases. The common objectives of these programs is to upgrade progressively the the performance and scope of existing tandem designs, with an ultimate aim of providing the research scientist with a complete freedom in his choice of nuclear collisions. (auth)

37288 ION–GAS COLLISIONS DURING BEAM ACCELERATION. Kellogg, E. M. (Radiation Dynamics, Inc., Westbury, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 242-6(June 1965).

An attempt is made to understand the effects which residual gas in an accelerator beam tube can have on the ion beam passing through it, and on certain other aspects of the accelerator's performance. The approach to the problem is considered to be the most fundamental. That is: all possible collision processes between injected beam and residual gas are examined; a uniform axial electric field is assumed, together with a pressure gradient determined by kinetic theory equations for gas conductance assuming the source of gas to be the ion source. In principle, it is then possible to calculate the resulting energy spectra of positive, neutral, and negative beam, as well as backstreaming electrons, evolved when only a positive ion beam is injected. In practice, only a numerical solution of the resulting equations can yield a solution. This solution is carried out, and the results are discussed. (auth)

37289 PRODUCTION OF PROTONS AND NEGATIVE IONS WITH LOW ENERGY SPREAD. Collins, L. E.; Gobbett, R. H.; Stroud, P. T. (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 247-50(June 1965).

The suitability of the duoplasmatron and r–f ion source for the production of low energy spread beams required for klystron bunching on Van de Graaff accelerators has been investigated. An increase in the proton and negative ion beams obtained from the duoplasmatron source can be achieved by extracting from the edges of the arc. The energy spread depends on the source conditions and varies from 8 to 50 ev. In r–f sources the energy spread is influenced by the oscillator design and coupling and is less than 50 ev for a push-pull system. (auth)

37290 THE TANDEM AS A HEAVY ION ACCELERATOR. Rose, P. H.; Purser, K. H.; Wittkower, A. B. (High Voltage Engineering Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 251-6(June 1965).

Tables of the estimated energies obtainable with three types of tandem accelerator are presented with a brief discussion of the problems of heavy ion generation and acceleration. (auth)

37291 A SOURCE OF He^{2+} IONS FOR A VAN DE GRAAFF ACCELERATOR. Weil, J. L. (Univ. of Kentucky, Lexington and Rice Univ., Houston, Tex.); Taylor, I. J. IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 257-61(June 1965).

An ion source for the production of well-collimated beams of doubly charged helium ions was constructed, tested, and put into operation. It consists of an einzel lens to maintain a well-focussed beam and a crossed field analyzer that permits only one component of the beam to leave the source assembly. Beam currents of 1 to 2 microamperes of analyzed $(He^4)^{2+}$ or $(He^3)^{2+}$ ions are obtainable from the source assembly for acceleration in a Van de Graaff generator. Up to 0.25 microamperes of $(He^4)^{2+}$ beam has been obtained at the entrance to the beam tubes after acceleration in a Van de Graaff generator and after momentum analysis, but this figure is subject to improvement. The source can also be used with H^+, D^+, and He^+ ions. By applying an r–f voltage to the deflector plates, it was found possible to pulse the singly ionized beams. A pulsed beam of ½ μa of $(He^3)^+$ ions with a pulse width of 7 ns has been obtained. The design and installation of the source is described. (auth)

37292 A 14 Mev NEUTRON SOURCE CAPABLE OF DELIVERING A 1000 RAD DOSE UNIFORMLY OVER A 6 × 6-FOOT AREA. Fleischer, A. A.; Jorgensen, N. E.; Nissen, R. F.; Wells, D. K.; Younger, F. C. (William M. Brobeck and Associates, Berkeley, Calif.) IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 262-5(June 1965).

Some aspects of a feasibility study on a high flux, large area 14 Mev neutron generator are described. The purpose of this study was to provide a preliminary design of a 14 Mev neutron generator capable of uniformly delivering a 1000-rad dose to a 6 × 6-foot target. A source of about 2×10^{13} 14 Mev neutrons per second for four hours yields a 1000-rad dose with a uniformity of ten per cent to a 6 × 6-foot target located ten feet from the source. There are numerous charged particle reactions capable of yielding significant numbers of 14 Mev neutrons, but the requirement for mono-energetic 14 Mev neutrons precluded all reactions but the (d–T) reaction. The 14 Mev neutrons are produced by a 250 mA deuteron beam with 250 kev energy impinging on an 18-inch diameter tritiated-titanium target. The use of a large area tritiated-titanium target makes target cooling and depletion problems manageable. (auth)

37293 SULPHUR HEXAFLUORIDE—ITS PROPERTIES AND USE AS A GASEOUS INSULATOR IN VAN DE GRAAFF ACCELERATORS. Ashbaugh, P. G.; McAdam, D. W.; James, M. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 266-9(June 1965).

Investigations into the use of sulfur hexafluoride as an insulating gas for Van de Graaff accelerators have resulted in the decision to use it in the MP tandem accelerator presently being installed at Chalk River. Observations on a 3 megavolt vertical Van de Graaff and the EN 10 Mev tandem accelerator show that there are no problems due to the use of SF_6 which cannot be solved with normal engineering procedures. An outline is given of the physical and electrical properties, and a method of detecting and removing the corrosive breakdown products is described. The gas handling system for the MP accelerator and a system for air removal are described. An economic and functional comparison with a system using a 4:1 mixture of N_2-CO_2 is given. (auth)

37294 ELECTRON ACCELERATORS FOR ELECTRON MICROSCOPY IN THE 1 Mev RANGE. Reinhold, G.; Minkner, R.; Adler, H. (Emile Haefely and Co. Ltd., Basel). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 270-3(June 1965).

The use of electron accelerators for electron microscopes of very high voltage is described. The 1.5 Mev electron accelerator for the world's largest electron microscope at Toulouse, France is discussed as well as the 750 kv electron accelerator now under construction for the electron microscope at the Cavendish Laboratory of the University of Cambridge, England. In this type of application a very high stability is demanded of the electron accelerator. A discussion is given of how this stability is achieved and what the limitations are for obtaining even higher stabilities. (auth)

37295 A WIDE AREA ELECTRON BEAM SCANNER. Rossi, M. L.; Favale, A. J.; Swanson, F. R.; Lotito, F. J. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 279-81(June 1965).

A wide-area electron beam scanner, which utilizes a single three-phase electromagnet was designed and constructed for use with Grumman's 3 Mv Van de Graaff accelerator. The uniformity of the beam scan was measured, and between radii of 1 and 4½ inches was found to be constant to within ±10 percent (%). (auth)

37296 A NEW LOW ENERGY HEAVY ION ACCELERATOR. Laubert, R.; Wotherspoon, N. (New York Univ., New York). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 282-7(June 1965).

A heavy ion accelerator and beam transport system were designed and constructed for studies of the interaction of radiation with matter. The air-insulated electrostatic accelerator was made with a beam energy continuously variable from 2–200 Kev. A modified duoplasmatron ion source provides ions of hydrogen, nitrogen, oxygen and noble gases at beam currents as high as 5 ma. The accelerating potential is provided by an oil insulated power supply regulated to ±0.01%. The beam transport system consists of a water-cooled insulated slit, magnetic spectrometer for beam definition of energy, charge state and isotopic composition, and a target chamber. A second magnetic spectrometer is available for further particle energy definition or for momentum analysis of the ion beam after interaction with a target. An extensive series of experiments for evaluating the accelerator performance is described, and results are reported for typical beam current density profiles, emittance areas, and maximum current densities attainable for different ions at various beam energies. (auth)

37297 THE SYMMETRICAL CASCADE RECTIFIER—AN ACCELERATOR POWER SUPPLY IN THE MEGAVOLT AND MILLIAMPERE RANGE. Reinhold, G.; Truempy, K.; Bill, J. (Emile Haefely and Co. Ltd., Basel). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 288-92(June 1965).

A description is given of the symmetrical cascade rectifier and a comparison is made with the standard Cockcroft-Walton generator. The formulas for voltage drops of both types of generators are compared, which illustrate the higher voltage capabilities of the symmetrical type. The realization of a 4 Mev accelerator based on the symmetrical cascade rectifier is presented. (auth)

37298 STABILIZED HIGH VOLTAGE DC POWER SUPPLIES OF THE SHIELDED DESIGN. Reinhold, G.; Minkner, R.; Truempy, K. (Emile Haefely and Co. Ltd., Basel). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl Sci., NS-12: No. 3, 293-5(June 1965).

Recent progress in the design of the fully enclosed, stabilized high voltage power supply is described. The performance characteristics and operating life of a 600 kv power supply of this type are discussed. (auth)

37299 ENERGY REGULATION OF A 3 Mv VAN DE GRAAFF POSITIVE ION ACCELERATOR BY MODULATION OF THE ION SOURCE DARK CURRENT. Isaila, M. V.; Allen, H. L. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 296-8(June 1965)

As a result of work on a scheme to regulate the energy of the 3 Mv Van de Graaff injector at this installation, it was found that several disturbing effects were produced upon closing the energy control feedback loop using a beam derived signal for modulation of the corona current. These undesirable effects, which are mainly a result of the long ion transit time and ion dispersion in the high pressure gas, seriously limited the manipulation and the analysis of the regulation problem. To circumvent these difficulties, it was decided to modulate the dark current (D.C. beam current) of the pulsed positive ion source by means of a variable intensity light signal transmitted to a photomultiplier tube in the high voltage terminal through a plexiglass pipe. This approach provided a rational transfer function permitting a more straight forward analysis of loop operation, a higher frequency response and greater reliability of operation all of which resulted in improved energy regulation from about ±1.5 Kv to about ±500 v. The existing servo loop on the corona current was retained as a back-up element and it continues to handle the major portion of the slow energy regulation. (auth)

37300 ION PUMP OPERATION OF A 5.5 Mev AND 12 Mev VAN DE GRAAFF ACCELERATOR. Adams, Charles T. (Univ. of Pennsylvania, Philadelphia). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 299-304(June 1965).

An improved vacuum system, using combined ion and cryo-pumping techniques was successfully used on Van de Graaff accelerator beam tubes. The pumping through-put of the ion pumps proved more than adequate in handling tube discharges. Base pressures are in the mid 10^{-7} torr range, while operating pressures have been improved by factors of 2–9 over Hg diffusion pumped systems. System maintenance was virtually eliminated. Descriptions are given of ion pump starting techniques, roughing systems and characteristic operation of ion pumping and combined ion and cryo-pumping on a C.N. and E.N. accelerator. (auth)

37301 THE PRODUCTION OF INTENSE NANOSECOND AND SUBNANOSECOND BEAM PULSES FROM TANDEM ACCELERATORS. Naylor, H.; Purser, K. H.; Rose, P. H. (High Voltage Engineering Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 305-12(June 1965).

A short review is presented of the factors involved in the production of intense bursts of ions having nanosecond duration from tandem accelerators. For the specific example of the High Voltage Engineering Corporation's model MP tandem it is shown that, if velocity modulation is applied to the beam at the appropriate point and if a nondispersive arrangement of elements is used in the post-acceleration beam-transport system, the existing source and the injection optics should permit pulsed beams of the hydrogen isotopes to be available at several target positions with energies up to 20 Mev, burst widths of ~ 1nS and peak intensities of ~500μA. The advantages are emphasized of having ions of variable energy available at the modulator and it is shown that this feature can permit the use of sources of large inherent energy spread and also the production of pulsed beams from a variety of heavy ions. The concept of multiple bunching is introduced and it is shown that the use of this technique would allow the production of burst intensities of several milliamperes and also ultra-short pulses ($\tau \sim 5 \times 10^{-11}$ sec). (auth)

37302 A HIGH EFFICIENCY ION OPTICAL SYSTEM FOR TANDEM ACCELERATORS. Brooks, N. B.; Bastide, R. P.; Purser, K. H.; Roos, M.; Rose, P. H.; Wittkower, A. B. (High Voltage Engineering Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 313-16(June 1965).

The ion optical problems of injecting ions into a tandem are reviewed and it is shown that significant improvements in transmission efficiency are to be expected if the diameter of the terminal stripping canal is increased and if the electrostatic field at the entrance to the accelerator is terminated in a controlled manner. Results with an experimental tandem accelerator are reported. (auth)

37303 MAGNET DESIGN IN HIGH-ENERGY ACCELERATORS. Blewett, M. Hildred (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 317-26(June 1965).

The similarities and differences in magnet design of the presently existing multi-billion-volt accelerators are reviewed. Special emphasis is given to the requirements for alternating-gradient synchrotrons, particularly as exemplified by the Brookhaven AGS. Details include pole-contour shaping, choice of steel, coil design and power-supply requirements together with more general considerations of mechanical and electrical problems. (auth)

37304 MAGNETIC FIELD CONTROL IN THE MANITOBA CYCLOTRON. Burgerjon, J. J.; Konopasek, F.; Standing, K. G. (Univ. of Manitoba, Winnipeg). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 334-7(June 1965).

Two unusual methods to make local changes in the magnetic field are described—movable steel plugs at the center and temperature-controlled Invar blocks at larger radii. The plugs have 2'' holes at the center, which produce a dip in the magnetic field. This appears to have no serious effect on the beam. Results of beam extraction by H^- ion stripping are reported. (auth)

37305 RING MAGNET POWER SYSTEM FOR THE ZERO GRADIENT SYNCHROTRON. Sellers, J. F.; Frisby, E. F.; Praeg, W. F.; Visser, A. T. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 338-43(June 1965).

The power system for the ZGS ring magnet consists of a flywheel motor generator set and four groups of mercury arc rectifiers operating alternately as power rectifiers and power inverters. The system is shown schematically. (auth)

37306 MAGNET EXCITING COILS. Jacobus, David D. (Harvard Univ., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 344-8 (June 1965).

Magnet exciting coils which were built at the Cambridge Electron Accelerator are described. The indices used in designing the coils are given, and the properties of various types of insulation are evaluated. The fields obtained in bending magnets and in quadrupole magnets were measured, and the magnetic efficiencies of the flux circuits are recorded. Designs of some unique coils are shown, which include the following: the exciting coils on the alternating gradient magnets of the accelerator, the coils on the choke that powers the accelerator, a bending magnet, a quadrupole magnet, and the large solenoid coil on a spark chamber magnet. (auth)

37307 FREQUENCY DEPENDENCE OF THE RESISTANCE AND INDUCTANCE OF SOLID CORE MAGNETS. Gonzalez, Gustavo R.; Brambilla, Amedeo (Cambridge Electron Accelerator, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 349-53(June 1965).

A simple model from basic field theory is used to obtain expressions for the equivalent dynamic resistance and inductance of non-laminated iron core magnets when small amplitude sine waves modulate the d-c magnet excitation. The approximations involved when applying the model equations to practical magnets are discussed. Deviation of calculated values from experimental data is of the order of 10% when the level of magnet excitation is low. Computed values of R and L may be used for field stability and ripple reduction studies. (auth)

37308 THE ARGONNE ZGS MAGNET. Foss, M. H.; Khoe, T. K.; Krizek, R. J.; Siljander, W. A. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 377-82(June 1965).

An essential part of the Argonne Zero Gradient Synchrotron is the large pulsed magnet approximately 180 ft in diameter. This magnet consists of eight curved sections or octants connected by long and short straight sections. It was designed to yield an external proton beam at magnetic fields up to 21.5 kilogauss. Major considerations in the design, fabrication, testing, and installation of the magnet and its coils are discussed. (auth)

37309 UNIFORM-FIELD WEDGE MAGNETS: DESIGN. Godlove, Terry F.; Bendel, Warren L. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 383-4(June 1965).

The design of a uniform-field magnet for achromatic deflection systems is considered, assuming that the entrance and exit fringe fields may be replaced by suitably located thin lenses for the purpose of calculating the transverse focusing. (L.B.S.)

37310 UNIFORM-FIELD WEDGE MAGNETS: RESULTS. Bendel, Warren L.; Godlove, Terry F. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 385-6(June 1965).

Formulas for the radial and transverse focal distances for uniform-field wedge magnets are applied to the symmetric case and to 35 and 45° double-focusing magnets. (L.B.S.)

37311 POLE FACE SHAPE DESIGN IN HIGH-ENERGY ACCELERATORS. Iliescu, C. C. (Inst. of Atomic Physics, Bucharest). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 387-91(June 1965).

An analytic method for designing pole face shape is presented, which gets the desired value of the field index in a given region, with a prescribed error. The method has three stages, corresponding to the successive computation of: the ideal pole face shape and ideal equipotential set; the equipotential set, taking into account fringing field effects, by means of conformal mapping; the necessary corrections at the edges of the ideal pole face by means of conformal mapping, for obtaining the desired field distribution. As an example, the pole face shape for a 300-Bev synchrotron with n = 5040 is computed. The method applies to every magnetic device having a radially constant field index. (auth)

37312 THE FOCUSING AIR-CORE MAGNETIC CHANNEL FOR THE M.S.U. 55-Mev CYCLOTRON. Berg, R. E.; Blosser, H. G. (Michigan State Univ., East Lansing). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 392-4(June 1965).

In variable-energy cyclotrons, saturation effects are always a problem; the use of air-core coils instead of iron as magnetic channels greatly reduces such difficulties. The design of such a coil for the M.S.U. 55-Mev cyclotron is described. The coil includes the additional feature of incorporating a focusing gradient approximately equal in strength to a typical single-stage quadrupole. (auth)

37313 MAGNETIC FIELD MEASUREMENT AND SPECTROSCOPY IN MULTIPOLE FIELDS. Cobb, J. K.; Muray, J. J. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 395-400(June 1965).

The magnetic field measurements in multipole magnetic fields, which are used to measure magnetic field parameters in the strong-focusing lenses for the Stanford two-mile linear accelerator, are reviewed. Specifically, the theory and the measurement processes used to determine such important parameters as the magnetic center in multipoles, the length of the gradient fields, and the harmonic content in strong-focusing lenses are described. The results of these accurate measurements are related to the optical parameters of the multipole lenses. (auth)

37314 MEASUREMENT AND SHAPING OF THE FRINGING FIELDS OF THE PRINCETON-PENNSYLVANIA ACCELERATOR MAGNETS. Awschalom, M.; Isaila, M.; Reardon, P. J.; Shoemaker, F. C. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 401-4 (June 1965).

The fringing fields must be included in the determination of the effective length and field index of the Princeton Synchrotron weak focusing magnets. For this purpose, a null method was used to compare the magnetic field inside the gap with the fringing field integrated along a line perpendicular to the magnet end. $B_y(r,t)$, the field component normal to the median plane varied between 0.26 and 13.9 Kgauss, at 20 cps. The measuring technique consisted in placing a short line dipole coil in the known and essentially two dimensional field and a long dipole coil through the fringing field free region. The measurements gave the effective length of the fringing fields to $\pm 5 \times 10^{-3}$ in., at B minimum, and $\pm 5 \times 10^{-4}$ in., at B maximum. The results were used to analyze and guide the design of correcting end pole pieces which produced the desired effective length and average field index. This work was performed on the full scale prototyped magnet. The excellence of the actual magnets was checked with the proton beam. (auth)

37315 MEASUREMENT OF THE MAGNETIC MEDIAN SURFACE OF THE PRINCETON-PENNSYLVANIA ACCELERATOR. Awschalom, M. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 405-7 (June 1965).

A description is made of the equipment used to determine the position and shape of the magnetic median surface (m.m.s.) of the Princeton Synchrotron weak focusing magnets far from the magnet ends. The reproducibility of the relative profiles of the m.m.s. was ±0.020 in. or better. The absolute location of the m.m.s. was uncertain to ±0.1

in. The effects of current sheets through the pole piece face windings and current loops on the front spacer as well as the profile of the m.m.s. were measured for many values of B(r,t), from B minimum to B maximum. (auth)

37316 COMPUTER CALCULATIONS OF THE MAGNETIC FIELD OF ALTERNATING GRADIENT SYNCHROTRON MAGNETS. Dahl, P. F. (Brookhaven National Lab., Upton, N. Y.); Parzen, G.; Christian, R. S. IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 408-11(June 1965). (BNL-8904)

The computer program SIBYL was applied to computing the magnetic field of the Brookhaven AGS magnets and a Brookhaven septum magnet. The results are presented and compared with experimental results. (L.B.S.)

37317 EXPERIMENTAL AND EXTERNAL-PROTON-BEAM MAGNET POWER-SUPPLY SYSTEMS AT THE BEVATRON. Jackson, Leslie T. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 416-20(June 1965). (UCRL-11793)

Magnet power-supply systems for both experimental and external-proton-beam (EPB) magnets used at the Bevatron are described as feedback control systems. Individual components contained in the systems are also described. The power-controlling component first used in the supplies was a three-phase magnetic amplifier. Silicon-controlled-rectifier (SCR) bridges are now being used. The requirements placed on the experimental magnet supply systems are ±0.1% current regulation with ±10% line-voltage perturbations occurring every pulse of the Bevatron. The EPB systems must track to at least ±0.1% a dynamic signal closely related to the proton beam energy. The performance criteria for EPB systems involve both error coefficients and transient response. (auth)

37318 FIELD CONTROL TYPE CURRENT REGULATOR FOR ELECTROMAGNETS. Cilyo, Frank F. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 421-4(June 1965).

A system is described for regulating current in electromagnets of more than 1 H inductance and requiring more than 50 kw of power. Current stability of better than 1 part in 50,000 was realized using this system with the main magnet coils of the Argonne 60-inch cyclotron. Design is based on the classical approach in which current through the generator load is controlled by the current through its field rather than the presently popular use of series transistor design. It incorporates advantages of developments in the fields of feedback control and solid state devices to provide a simple, reliable and flexible system. During startup, to minimize overshoot and consequent hysteresis effects, a voltage loop is used for control. For precise, long term regulation, a current loop is added in which the current through the magnet is controlled by a preset current reference signal or a magnetic field reference signal obtained from a nuclear magnetic resonance probe. (auth)

37319 CONTROL OF TRIM COIL CURRENTS BY RHEOSTAT BRIDGES WITH EFFICIENCIES ABOVE 80 PER CENT. Atwood, Jesse R.; Fredriksson, Olof K. (William M. Brobeck and Associates, Berkeley, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 425-6(June 1965)

The 40 trim coil circuits of the 70-inch cyclotron being installed at the Naval Radiological Defense Laboratory are to be powered by a remote power supply which energizes 40 series-connected rheostat bridge circuits located on the cyclotron proper. The rheostat bridges will have a maximum power efficiency in excess of 80%. (auth)

37320 HIGH REPETITION RATE PULSERS FOR BEAM SWITCHING MAGNETS. Cole, J. L.; Lutz, I. C.; Muray, J. J. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 430-3 (June 1965).

The description is given of a type of pulsed power supply which was developed to energize deflection magnets with a field of either direction, for a right or left beam deflection, on a pulse-to-pulse basis, at repetition rates up to 360 pulses per second, and to recover most of the energy at the end of the pulse. The scheme consists basically of using ignitron tubes to switch energy stored in a capacitor bank to the pulsed magnet and back to the capacitor bank with relatively small losses, and using a d-c supply to recharge the capacitor bank between pulses. (auth)

37321 OPERATION OF A 3 Gev FAST CYCLING PROTON SYNCHROTRON. Tomlinson, E. P. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 445-8(June 1965).

The Princeton-Pennsylvania Accelerator operates at approximately 19 pulses per second. It quite consistently achieves 1 to 2×10^{10} protons per pulse and has been tuned up to an intensity of 5 to 6×10^{10} protons per pulse. Since August 1963 it has been serving simultaneously one to four prime users, plus a similar number of parasites, with beams of π and K mesons generated in an internal stationary target, usually platinum. Beam spill is achieved over a time of 2 to 4 msecs with some synchrotron oscillation structure and 100% r-f structure. The latter has been used effectively in some experiments as a means for velocity selection in momentum analyzed beams. In addition to serving experiments, current major efforts of the staff are directed toward increasing stability and intensity, improving overall reliability in general and spill control in particular, preparing for an external proton beam, and accumulating equipment and experienced manpower for general support of experiments. Operating schedules and procedures are described. (auth)

37322 PRACTICAL OPERATING PROBLEMS AT THE R.P.I. LINAC. Krasse, R.; Fullwood, R.; Browne, R. (Rensselaer Polytechnic Inst., Troy, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 449-56(June 1965).

Practical operating problems of an electron accelerator facility are presented with their solutions. Organization, maintenance, and training problems and procedures are presented in general. Klystron failures, thyratron replacement, and voltage standing wave ratio as technical problems are discussed and their solutions documented. (auth)

37323 A COMPARISON OF THEORETICAL AND ACTUAL BEAM PERFORMANCE OF A 140 Mev ELECTRON LINEAR ACCELERATOR AT THE UNIVERSITY OF SASKATCHEWAN. Haimson, J. (Varian Associates, Palo Alto, Calif.); Katz, L. IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 457-61(June 1965).

The electron beam optics of the injector and microwave system of a two klystron, four-section linear accelerator with an unloaded beam energy of 140 mev are discussed. The injector contains a microwave chopper, a nanosecond inflector and a prebunching assembly so that a wide variety of different injection conditions can be presented to the machine. The waveguide sections are of nonuniform impedance design and each is energized by 8.5 megawatts peak r-f power. The design parameters of the waveguide sections are discussed together with the electron beam dynamics for various modes of injector operation, and some comparisons are made with measurements of the electron beam characteristics. (auth)

37324 POSITRON PRODUCTION WITH THE USNRL LINAC. Toms, M. Elaine; Godlove, Terry F. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 462-4(June 1965).

Positrons produced by electrons peaked at energies of 9.6, 10.8, 11.7, 13.5, 15.0 and 16.6 Mev incident on a 0.8 radiation length gold target, were accelerated to 35 mev. Their spectra were measured by means of a defining slit system, set for 2 percent energy transmission, located at the focal point of a 90° achromatic deflection system. Experimental values of conversion efficiency were fitted by the expression $\epsilon = 3.3 \times 10^{-7}$ (E-4.7), where E is the energy of the incident electrons. The expected positron

current for the highest repetition rate (720 pulses per second) is approximately 4×10^{-10} amperes over electron energies from 10 to 14 Mev. (auth)

37325 A POSITRON LINEAR ACCELERATOR DESIGN. Nunan, Craig S. (Varian Associates, Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 465-9(June 1965).

A 450 Mev electron 350 Mev positron linear accelerator system is described which has been designed as an injector for a storage ring. Several positron containment systems are considered and a stepped solenoidal magnetic field is chosen as optimum with the converter immersed in the high magnetic field. The parameters of this system are derived for maximum positron beam within specified energy spread and emittance. Performance is reported for initial operation at 40 Mev positron energy. (auth)

37326 A STORAGE RING FOR 10 Bev MUONS. Tinlot, John; Green, Daniel (Univ. of Rochester, N. Y.). IEEE (Inst. Elec. Electron, Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 470-5(June 1965). (UR-875-76)

It is proposed to construct a strong focusing ring of magnets whose function is to trap muons of 5 to 10 Bev, and to study the interaction of the trapped particles in targets placed in the ring. It is shown that such a ring is especially suitable for use with the Stanford linear accelerator because of the hundred-fold increase in effective duty cycle. Other advantages of the scheme are that the muons are nearly mono-energetic, free of contamination, well collimated, and confined to a small beam well suited for performing scattering experiments. Typical parameters of the trapping ring are presented. (auth)

37327 COMPARISON OF COLLIDING AND SINGLE BEAM PROTON ACCELERATORS. Brobeck, William M. (William M. Brobeck and Associates, Berkeley, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 476-8(June 1965).

Above the presently available energies, the center-of-mass energy per dollar of colliding beam accelerators becomes greater than that of single beam machines. As the energy increases, the economy of colliding beams becomes more pronounced. The difficulties in using colliding beams are typical of the difficulties accompanying each step made into a higher energy region. It is argued that colliding beams are usable and that the ability to enter an energy region otherwise unattainable justifies the difficulties. Preparing for a major colliding beam installation to come into operation around 1985 is suggested. (auth)

37328 AN ACCELERATOR FOR ISOTOPE CONVERSION—THE RECYCLE ACCELERATOR. Zucker, M. S.; Steinberg, M.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 479-83(June 1965).

The nature of charged particle-complex nuclei reaction cross sections suggests an isotope conversion accelerator in which a circulating beam kept at constant energy repeatedly traverses a thin target. Statistical deviations in target energy loss and emergent direction induce betatron and synchrotron oscillations. These limit the number of traversals before particle loss, but to useable values. However, the requirements of storage ring injection may reduce the advantage of this accelerator over conventional types. (auth)

37329 PROPOSED HIGH INTENSITY, HIGH ENERGY CYCLOTRON FOR LIGHT AND HEAVY IONS. Livingood, J. J.; Khoe, T. K.; Ramler, W. J.; Johnson, K. W.; Mavrogenes, G. S.; Winje, R. A. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 484-8(June 1965).

Since ions with small charge are produced more copiously from ion sources than are highly charged particles, it is proposed to construct a sector-focused cyclotron of large diameter to obtain heavy ions in much greater number and at higher energies than are available from existing cyclotrons or linacs. In addition, the machine will produce protons at 120 Mev and other light ions in excess of 120 Mev. (auth)

37330 A WAVEGUIDE RESONANT RING ELECTRON ACCELERATOR. Winter, Stuart D. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 494-8(June 1965). (UCRL-12216-T)

An analysis is made of a proposed accelerator, less than 1 meter long, and capable of accelerating bunched electrons with a peak current of 100 A for a period of 50 r-f cycles (20 nsec). The accelerator consists of an S-band disk-loaded circular waveguide, similar in design to the SLAC machine, incorporated into a waveguide resonant ring. Analysis of this system indicates that significant power buildup can occur if the length of the accelerator part of the ring is less than 1 meter. Further analysis of the power buildup and energy storage is made for a variety of rings having an accelerator section which is three, four, and five wavelengths long. Following the initial buildup of ring energy a beam of current bunched into 1/6th wavelength (60°), having a peak value of 100 A and an initial energy of 100 kv, is injected into the first cavity of the accelerator. Such a beam would extract half of the energy within the ring in approximately 20 nsec and have a nominal output energy of 10 Mev. By operating at 100°K, five such accelerators could be pumped by the same power source, thus increasing the output energy level to 50 Mev. The problem of handling a 100-A beam at low velocities is also investigated and a method utilizing space-charge neutralization by ionized gas is discussed. (auth)

37331 INJECTOR AND WAVEGUIDE DESIGN PARAMETERS FOR A HIGH ENERGY ELECTRON-POSITRON LINEAR ACCELERATOR. Haimson, J. (Varian Associates, Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 499-507(June 1965).

A discussion is given of the electron beam optics design of a six klystron, twelve section, 450 Mev electron 350 Mev positron linear accelerator which was designed as an injector for a storage ring. The beam centerline comprises three zones; namely, the injection system, the high current waveguide sections and the high energy gain sections. The injection system is arranged such that the beam from a pulsed diode source is chopped and prebunched at 2856 Mc to provide well defined tightly focussed short bunches of electrons for injection into the first accelerator section. A nanosecond inflection system, located between the chopper and prebuncher cavities, provides variable short pulse capability as well as 9.5 Mc modulation of the beam to produce a train of short pulses during each gun pulse. The first four waveguide sections are designed for an unloaded beam energy of 107.5 Mev, and 500 ma peak current at 60 Mev with 10 Mw peak r-f power at each input coupler. A positron converter is located at the end of these sections and immediately prior to the high energy gain portion of the machine which comprises eight waveguides each of which is 504 cm in length and designed for an unloaded beam energy of 45.4 Mev with 10 Mw peak r-f input power. Details of the microwave design parameters and some electron beam characteristics are presented together with preliminary measurements of actual beam performance. (auth)

37332 GENERAL DESCRIPTION OF THE NRL SECTOR-FOCUSING CYCLOTRON FACILITY. Bondelid, Rollon O. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 508-11(June 1965).

The nuclear physics research facilities at NRL are presently being expanded by the addition of a Sector-Focusing Cyclotron Facility. The cyclotron is essentially a copy of the Oak Ridge Isochronous Cyclotron and much of the facility concept is patterned after the Oak Ridge Installation. A beam optics system was designed that satisfied the specified criteria as to image quality, and then a building design was coupled to this beam optics system. Included in the facility are a cyclotron and beam preparation vault, and three experimental rooms which are sufficiently well shielded from each other and from the cyclotron vault, so that personnel have access to any two experimental areas while the

third is utilizing the cyclotron beam. Eleven separate beam paths will permit set-up of many different experiments simultaneously. The main experimental wing of the building also includes two experimental staging areas, a control room, and a data accumulation room. A laboratory-office wing provides space for check-out of various apparatus, a target preparation room, a machine shop, a dark-room, counting rooms, a library, a conference room, and offices for the staff. The facility will be used to study nuclear interaction mechanisms, polarization phenomena, nuclear structure, heavy ion, and neutron physics, as well as various areas of applied research. (auth)

37333 USE OF AN ISOCHRONOUS CYCLOTRON FOR NEUTRON TIME-OF-FLIGHT EXPERIMENTATION. Howe, H. A.; Svanheden, A.; Reiser, M. (Naval Radiological Defense Lab., San Francisco). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 512-16(June 1965).

The design of the U. S. Naval Radiological Defense Laboratory's (USNRDL) cyclotron for the production of subnanosecond, high intensity, charged particle beam pulses for neutron time-of-flight experiments, is described. Klystron bunching of the extracted cyclotron beam is possible for short bunching path lengths between cyclotron and target but it demands a beam of large energy spread — greater than 1%. A method of linearizing the effect of the sinusoidally varying, accelerating potential is described, and it is shown that klystron beam bunching is possible with reduced beam energy spread. It is seen that the cyclotron competes with single stage, d-c accelerators for neutron time-of-flight experimentation and will furnish large beam currents at higher energies in excess of the beam currents contemplated for the d-c tandem machines. (auth)

37334 POWER SYSTEM OPERATION AT THE CAMBRIDGE ELECTRON ACCELERATOR. Henry, William S. C. (Harvard Univ., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 517-18(June 1965).

The laboratory requires a large amount of electric power to produce the high energy particles and perform the physics research. This makes it important to operate the power system with maximum efficiency and economy. The problems and actions taken to accomplish these objectives are discussed. (auth)

37335 PROBLEMS IN THE DESIGN OF CRYOGENIC TARGET FACILITIES FOR ELECTRON SCATTERING EXPERIMENTS. Kaiser, H. F. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 519-26(June 1965).

A description is given of a proposed target facility for use in a program of electron scattering experiments at the Naval Research Laboratory electron linear accelerator on inelastic electron scattering experiments on low atomic number elements as ^{1}H, ^{2}H, ^{3}H, ^{3}He and ^{4}He, all of which in the liquid or solid state provide compact, high density, well localized, targets of pure elements. Problems discussed are: electron energy dissipation in cryogenic targets by continuous electron beams of 5 to 60 Mev energy, target design dimensions such as target diameter to beam diameter ratios, permitting maximum incident beam current, treatment of pulsed electron beams using instantaneous line source theory in estimation of maximum permissible current densities, vapor production and mechanical shock in targets based in part on bubble chamber theory, and thermal radiation into the target shields from the scattering chamber wall. (auth)

37336 THE NRL CYCLOTRON DATA ACQUISITION AND PROCESSING SYSTEM. Allas, Richard G. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 527-9 (June 1965).

In order to make effective use of the NRL Isochronous Cyclotron an efficient multipurpose data collection and data handling facility is designed. The central part of the system is a small general purpose computer with all digital data collection devices (examples are: timers, scalers, frequency meters, and digital voltmeters) feeding directly into the computer, thus eliminating a vast amount of time-consuming and error-causing paper work. The computer will also be used for multi-parameter and single-parameter multichannel analysis with ADC's feeding the computer memory directly. For rapid display of data, and any desired graphical display, a computer controlled CRT display will be used. A light pen will be used to select and modify information in the computer memory. The standard input-output equipment will consist of a typewriter, paper tape read/punch unit, two magnetic tape units, a graph plotter, and a fast on-line printer. The on-line time will be time shared between the (random) data collection and data processing and/or display. To make such concurrent operations possible a priority interrupt system will be used, with a higher priority system taking over computer control from a lower priority operation. (auth)

37337 FLEXIBILITY IN ACCELERATOR HOUSINGS. Mackinlay, Ian (William M. Brobeck and Associates, Berkeley, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 535-9(June 1965).

Flexibility in the design of accelerator housings is achieved by: proper site selection and planning; study of critical areas of design; proper selection of shielding materials; maximum use of non specialized spaces; correct selection of crane capacity and coverage; location of offices, laboratories and utilities to facilitate expansion; and provision of adequate space for counting room expansion. Proposals are presented for building construction techniques and arrangements that facilitate future expansion and modification of an accelerator housing. Recommendations are presented for shielding techniques which permit flexibility. Relationships between flexibility and cost are discussed for both building and shielding construction. (auth)

37338 CONTROLLING ACCELERATOR ENGINEERING COSTS. Avery, R. T.; Breuner, D. J. (William M. Brobeck and Associates, Berkeley, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 540-3(June 1965).

Cost control for accelerator engineering involves task definition, planning related expenditures, measuring progress, tabulation of costs and projections, and, most important of all, follow-up for corrections. Accelerator engineering costs are best regulated by the accelerator engineer, since those who are in any way detached from the work cannot exercise the most effective control. The accelerator engineer should be assisted by providing him with an effective system, appropriate forms and reports, and administrative support. (auth)

37339 A HYPERVELOCITY MICROPARTICLE LINEAR ACCELERATOR FOR USE IN MICROMETEORIC SIMULATION. Dingman, E. H. (Martin Co., Denver). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 544-9(June 1965).

Various means were developed to simulate micrometeorites in the laboratory. A system is described which is based on the Wideroe heavy ion accelerator principle. Conductive charged particles in the 0.1 to 5 micron diameter size range are accelerated in much the same manner as are heavy ions. The final velocities so far obtained were 10.8 kilometers/sec. This accelerator has been used to study the damage effects of hypervelocity particles to optical surfaces. The system provides a good simulation of the lower velocity type of cosmic dust most frequently encountered in space. The microparticle linear accelerator offers some advantages over the electrostatic type. However, all types of electric field accelerators used for hypervelocity work are limited to the smaller microparticle sizes due to the very large charge the particle must support. (auth)

37340 BEAM DIAGNOSTICS ON THE ZGS. Martin, Ronald L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 556-60(June 1965).

The detection equipment installed in the Zero Gradient Synchrotron (ZGS) is described. Most measurement techniques and equipment are similar to those of other synchrotrons with the possible exception of fluorescent screens of high transmission viewed by storage TV systems. These are found to be useful for a variety of diagnostic techniques at injection, such as measurement of equilibrium orbits, median plane, injection angles, and angular spreads. The value of these techniques, which depend upon the focussing properties of the synchrotron, lies in their ability to separate magnet effects from injection effects. These techniques are described in some detail. Also discussed briefly are some of the problems that were encountered, such as unbalanced ground currents, tune variation during the accelerating cycle, and a vertical instability with a sharp intensity threshold. (auth)

37341 BEAM LOADING IN LINEAR ACCELERATORS. Leiss, J. E. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 566-79(June 1965).

The interaction of the bunched particle beam in a linear accelerator with the waveguide structure produces several beam-loading effects. These effects include reduction, redistribution, and phase shift of the r-f field in the waveguide, changes in the tuning of the waveguide structure, excitation of other waveguide modes, and various transient phenomena. A discussion of these various effects and methods for their calculation are presented. (auth)

37342 BEAM DYNAMICS PROBLEMS IN A HIGH-ENERGY ELECTRON LINAC. Loew, G. A.; Helm, R. H. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 580-92(June 1965).

A discussion is presented of the beam dynamics for an ideal accelerator. The longitudinal and transverse properties of the electron beam of the Stanford linac are described and the effects and remedies of various types of imperfections are examined. A description is given of the diagnostic equipment needed to measure the characteristics of the beam and to determine the proper corrective actions. A discussion is also given on operational procedures for setting up simultaneous beams of different energies and currents. (L.B.S.)

37343 A STUDY OF SOME TRANSVERSAL MOTIONS OF THE ELECTRON BEAM OF A LINAC. Bergere, R.; Veyssiere, A. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 593-606(June 1965).

When the magnetic focusing field at the input of an electron linac increases the output accelerated current does not increase regularly. Such a behaviour is shown to be connected with rotations, in the output plane of the linac, of the center of charges of the beam. These rotations were displayed experimentally by means of a beam position monitoring system and related to the transverse momentum transferred to the beam by the spurious TM_{11} mode existing in the mode converter which changes at the input of the Saclay linac, the TE_{01} mode from the rectangular waveguide into a TM_{01} mode on the accelerator circular waveguide. (auth)

37344 OPTIMIZATION OF MAGNETIC LENSES FOR WAVEGUIDE PORTION OF A PROTON LINAC. Visscher, William M. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 617-22(June 1965).

A discussion of factors affecting the radial confinement of the beam in a waveguide proton linac is given. Simple analytic expressions are developed which check with computer results. Consideration of radial acceptance, tolerance to errors, cost, length, and complexity, seems to indicate that doublet magnetic lenses are preferable to triplets. (auth)

37345 A COMPUTER PROGRAM FOR OPTICAL MATCHING SYSTEMS. Ohnuma, Shoroku; Vitale, Joseph N. (Yale Univ., New Haven). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 627-9(June 1965).

A computer program was developed for finding an optical matching system of particle beams in the transverse (x-x', y-y') phase space. It is well-known that the two sets of symmetric quadrupole triplets could be easily obtained for this purpose starting from a thin lens approximation. However, a system composed of only four lenses (with a fixed geometry) is often desirable in order to save the available space. Four simultaneous algebraic equations for four unknowns (magnet strength) are solved numerically starting from a thin lens approximation and the solutions are improved successively. In general, the program finds the strength of each magnet in less than one minute (IBM 7094). Maximum beam excursion is also computed to find the best solution when there are several possible combinations. (auth)

37346 A STUDY OF FIELD DISTRIBUTION AND BEAM LOADING IN PROTON LINACS AT HIGH ENERGIES. Nishikawa, T. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 630-3(June 1965). (BNL-8946)

The effects of beam loading and wall losses in a cavity with multiple cells are studied by the method of normalized mode analysis for proton accelerators. The effects of tuning errors are also considered. It is concluded that the $\pi/2$ mode is superior to the π mode structure, which is often chosen for its optimum shunt resistance. (L.B.S.)

37347 CALCULATION OF PARTICLE TRAJECTORIES IN AN ION LINAC WITH SELF-FOCUSING ACCELERATING GAPS HAVING QUADRUPOLAR SYMMETRY. Boussard, D. (Universite de Paris, Orsay, France). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 648-51 (June 1965).

In linear accelerators with drift tubes the bunching of particles around the synchronous one is obtained at the expense of focusing. Nevertheless, it is possible to ensure simultaneous radial and axial stabilities if, in the accelerating gaps, the cylindrical symmetry is abandoned. If the potential function in a gap between two drift-tubes has quadrupolar symmetry, it is possible, with certain assumptions about the gap geometry, to expand this function as a double Fourier series. Thus it enables the transfer matrix from one drift tube to the next. Formulae giving axial and radial r-f impulses, obtained in the thin-lens approximation for the quadrupole symmetry planes are easily applicable. The effect of the r-f is due to circular and quadrupolar impulses; the former is independent of the meridian plane, whereas the sign of the latter changes from one quadrupolar symmetry plane to the other. The radial and axial motions of the particles cease to be independent. The chosen potential function enables the second order transfer elements containing the coupling terms between the two degrees of freedom to be calculated. (auth)

37348 A SLOAN-LAWRENCE ACCELERATOR WITH SELF-FOCUSING ACCELERATING STRUCTURE. Boussard, D.; Septier, A. (Universite de Paris, Orsay, France). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 652-5(June 1965).

It was previously shown that focusing in a linear accelerator with drift tubes can be achieved if the shape of the extremities of the drift tubes is suitably chosen. An attempt is made to build a low energy prototype of an ion accelerator in which the results obtained theoretically are exploited. With the focusing system, a current gain of about ten times to the unfocused machine was obtained. Without any preliminary bunching device, the output to input current ratio is as high as 10%, which is in good agreement with theory. (auth)

37349 INDUCED RADIOACTIVITY AND REMOTE HANDLING METHODS FOR ACCELERATORS. Gorka, Andrew J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 656-64(June 1965).

The improvement of accelerators for greater beam intensity brings on problems of high induced radioactivity in parts and hardware associated with these machines. Data showing the magnitude of induced activity at several existing installations are tabulated to forecast the ultimate levels. Magnitudes of several hundred R/hr. are predicted, thus showing the need for a logical approach to the problem in new machine design parameters and in remote handling. The proposed modifications of present accelerators are presented showing the different approaches taken and the philosophy upon which their criteria are based. Design in some cases is based upon the ultimate activity levels expected, while others plan to make improvements as the activity grows. Regardless of the approach, definite design features are mandatory to make them compatible to remote handling. These features take into account the inaccessibility to the activated equipment and the need for rapid assembly and disassembly. Modular design of apparatus with quick disconnect means for both the mechanical and electrical coupling is presented to fulfill the above needs. A review is made of the existing remote handling equipment and systems showing their shortcomings or possible application to accelerator work. This is supplemented with an explanation of what features must be present in remote handling systems to make them usable for accelerator use. Manipulators and remote handling devices used in hot cells are designed for operation within the confines of limited and selected space. Large accelerators, on the other hand, require highly maneuverable equipment that can work in large working volumes. Examples of apparatus of this nature are explained together with auxiliary support systems for operation from remote distances, including viewing equipment. (auth)

37350 EFFECT OF NUCLEAR RADIATION ON MAGNET INSULATION IN HIGH-ENERGY ACCELERATORS. Brechna, H. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 683-8(June 1965).

Magnet coil insulation consists of inorganic materials such as glass fiber, fillers, and organic thermosetting resins. Most of the usual insulation systems are damaged if subjected to high radiation levels such as those anticipated at the Stanford Linear Accelerator, where the expected dose rate may be as high as 10^{11} rads per year. Tests carried out at SLAC are described in which several commercially available insulations were found to deteriorate severely at total absorbed doses of as low as 10^{10} rads. Changes in molecular structure induced by radiation effects and degradation of electrical and mechanical properties are discussed. The development and testing of an organic insulation using Al_2O_3 filler which retained about 25% of its original strength at an absorbed radiation level of 3.25×10^{14} ergs · gr^{-1} are described. This insulation required minor changes in the usual winding and plotting technique prevalent in the industry. (auth)

37351 MICROWAVE AND FAST-ACTING VALVES AND VACUUM COUPLINGS FOR ACCELERATORS. Eldredge, Arnold L.; Keicher, Albert J.; Heinz, Marvin; Allyn, Richard J. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 694-8(June 1965).

The high vacuum requirements of the Stanford Linac plus the radiation produced by electron acceleration have made it necessary to design special vacuum and isolation components. Two of these are special purpose valves capable of operating in a vacuum system at 10^{-8} torr, and the third is a group of quick-disconnect couplings used for component installation in the beam switchyard area of the accelerator. One valve is an all-metal, 50-megawatt, S-band microwave valve used to isolate an evacuated rectangular waveguide feed system from exposure to air during the replacement of a klystron drive tube for the accelerator. The valve is built with a remeltable indium seal which provides for leak rates on closure below 24×10^{-8} std. cc He/sec. The second valve is a fast-acting unit that was designed for beam axis application within the disk-loaded waveguide accelerator structure. This valve also has an indium seal that is remotely remeltable and has a measured closing time of nine milliseconds. The group of quick-disconnect couplings, which are 6, 10 and 12-inch pipe sizes, are remotely operable, non-elastomer couplings used in the vacuum chamber system of the beam switchyard. The radiation intensity in this area is sufficient to make elastomer seals impractical and to require that replacement of switchyard components be done quickly and remotely. Indium is also used as a reusable seal for these couplings and can be re-formed mechanically to extend seal life. (auth)

37352 THE STANFORD TWO-MILE LINEAR ACCELERATOR VACUUM SYSTEM. Conviser, S. R. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 699-704(June 1965).

The vacuum system of the Stanford two-mile linac has been designed as nominally a very high vacuum system operating in the 10^{-6} to 10^{-8} torr region. Main vacuum pumps are of the getter-ion type; the pumps are connected to an all-metal system fabricated of stainless steel except for viton O-rings in the valve seats. The accelerator structure evacuated by this system consists of OFHC copper rectangular and disk-loaded waveguides with stainless steel flanges connecting the various portions of the structure. For completeness, a brief description of the vacuum system for the beam switchyard at the end of the accelerator is included because it is an integral part of the overall system. Conventional diffusion pumps are used to maintain pressures of 10^{-4} to 10^{-5} torr, i.e., nominally high vacuum. (auth)

37353 QUALITATIVE EFFECTS OF RADIATION DAMAGE ON EQUIPMENT AND COMPONENTS AT THE R.P.I. LINAC. Fullwood, R. R.; Gaerttner, E. R.; Krasse, R. (Rensselaer Polytechnic Inst., Troy, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 705-7(June 1965).

A summary of difficulties due to radiation induced damage in neutron producing targets and components is presented. Little difficulty was experienced considering the power levels at which the R.P.I. Linac was operated. (auth)

37354 RADIATION MEASUREMENT WORK AT THE PRINCETON-PENNSYLVANIA ACCELERATOR. Awschalom, M.; Larsen, F. L. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 708-11 (June 1965).

Since the Princeton accelerator has a proton current of 10^{12}, per second at 3 Bev, a careful study was made of its shielding requirements before construction began. The resulting design was proven to possess excellent attenuation characteristics and flexibility of adaptation for varying demands by experiments. The personnel dosimetry is based on Bonner spheres and tissue equivalent ion chambers as well as the more conventional ones. A comparison and discussion of measurements made with the two types of detectors is made. Results of dose, particle flux and radioactivation measurements inside and outside the main shield, are presented. (auth)

37355 AREA RADIATION MONITOR SYSTEM WITH LOGARITHMIC INDICATION AND AUDIO-VISUAL WARNING. Hiebert, R. D.; Jennings, H. K.; Engelke, M. J.; Henkel, R. L.; Lang, H. J. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 721-4(June 1965).

An improved radiation monitoring system was developed for the Los Alamos Van de Graaff accelerator to give a more believable measure of biological danger. The system was to be made more reliable through the minimization of vacuum tubes and relays. The problem of indicating varying levels of neutron flux without changing ranges was solved by a logarithmic count rate meter with a range from 1-5000 mrem/hour. The indicating system was to be expanded to give rapid visual information at the control room and other locations as well as audio alarms in the experimental area. By transistorizing all the electronic circuits and using only low voltages, both reliability and safety is improved. A gamma system, with a range from .01 to

10 r/hour, utilizing ionization chambers and an electrometer tube, is an integral part of the radiation system. It energizes the same alarm system as the neutron detectors. The system block diagram is shown. (auth)

37356 SERVO SYSTEM FOR AUTOMATIC DOSE CONTROL. Murphy, C. J.; Cooper, R. D.; Meyer, R. A. (Army Natick Labs., Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 725-7(June 1965).

Circuitry was designed and constructed such that conveyor motion past a scanned linear accelerator beam is automatically regulated as a function of average beam current. Using this, the ratio of average current to conveyor speed can be held constant, thereby eliminating beam current variation as a source of error in irradiation processing. In the system, the ratio of current to conveyor speed is computed, multiplied by a factor inversely proportional to the scan height, and displayed on a digital voltmeter. The current signal is derived from a secondary emission monitor within the accelerator, while the conveyor speed is sensed by a tachometer coupled with the conveyor drive assembly. The beam scan is detected by a pair of adjustable sensor bars which are perpendicular to the plane of scan. (auth)

37357 ZERO GRADIENT SYNCHROTRON RING VACUUM SYSTEM. Hanson, W. B.; Moenich, J. S.; Weberg, K. H. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 728-33(June 1965).

The Zero Gradient Synchrotron is a weak focusing machine. This makes possible multiturn injection which results in a high intensity beam. Ideally, all of the space between the magnet pole faces and the magnet coil would be utilized for beam injection. This need requires the vacuum chamber for the machine to have a large vertical aperture across a broad radial width. The chamber of the ring magnet vacuum system is a closed ring about 560 ft in circumference. Approximately three-fourths of this chamber length is within the eight magnet sections where the minimum cross-section exists (32 in. wide by $5\frac{1}{4}$ in. high). The closed magnet design restricts the pumps to positions on the straight section boxes between magnets, thus spacing these pumping stations approximately 70 ft apart. Space limitations, eddy current problems, and heat problems determined the design approach to the vacuum chamber within each of the eight ring magnets. The resulting design necessitates the need for both an inner and outer chamber, since the inner (high vacuum chamber) design cannot withstand a pressure differential of one atmosphere. (auth)

37358 ACCELERATOR VACUUM PROBLEMS: IN-LINE OIL TRAPPING BETWEEN THE STANFORD LINEAR ACCELERATOR AND THE BEAM SWITCHYARD. Hoyt, E. L.; Garwin, E. L. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 740-2(June 1965).

The thirty accelerator sectors (each 330 feet long) of the two-mile machine will be evacuated with sputter-ion pumps to pressure low enough to limit r-f breakdown and multipactor problems. After the beam leaves the accelerator it will be switched by pulsed magnets to one or more of the experimental areas through the 1000-foot beam switchyard. Due to the nature of the equipment in the beam switchyard and the requirements for inexpensive, non-elastomeric, remotely operable couplings, there will be a high probability for virtual and real leaks and a consequent need for continuous high throughput pumping. Oil diffusion pumps are therefore used to evacuate the four branching beam tubes of the beam switchyard. Some kind of in-line oil trap is needed to separate the clean, low pressure (10^{-7} torr), ion-pumped accelerator from the oil-pumped (10^{-4} torr) beam switchyard end of the machine. This trap should limit the amount of oil and organic fractions passing back through to the accelerator and should provide some of the impedance necessary to obtain the three-order-of-magnitude pressure difference between accelerator and switchyard. The pressure difference will be maintained by differentially pumping on each of two in-line vacuum impedances. One of these impedances will be a standard 10-foot section of disk-loaded waveguide and will act as an oil trap. When refrigerated, such a trap had measured transmission probabilities of 10^{-9} to 10^{-6} for heavy hydrocarbons. (auth)

37359 FAST ALL-METAL SIX-INCH VALVE. Boyd, John (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 743-5(June 1965).

A stainless steel, six-inch valve capable of closing in approximately 10 milliseconds was developed at the Stanford Linear Accelerator Center. The valve will be automatically and remotely operable, allowing it to be used in the SLAC beam switchyard area where high radiation levels will prohibit personnel access. The problems of triggering mechanical release, valve gate acceleration and deceleration, and vacuum sealing without elastomers appear to be solved. The knowledge gained relating to this type of gate valve predicts the future design of a valve with a 24-inch opening, capable of operating in time intervals of five to six milliseconds. (auth)

37360 A SOURCE FOR MULTIPLY-CHARGED IONS. Mavrogenes, G. S.; Ramler, W. J.; Turner, C. B. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 769-74(June 1965).

A hot cathode oscillatory discharge source was investigated for d-c operation to determine the charge-state yield of ions for carbon, nitrogen, oxygen, neon and argon gases and to determine the parameters that affected these yields and source stability. Source principles and construction are similar to that reported by Morosov, Papineau, and Basile. (auth)

37361 ION SOURCES FOR HIGH CURRENT TANDEM ACCELERATORS. Bastide, R. P.; Brooks, N. B.; Wittkower, A. B.; Rose, P. H.; Purser, K. H. (High Voltage Engineering Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 775-9 (June 1965).

An expanded plasma ion source is described which generates high current negative ion beams of hydrogen (~1mA) and helium (~3 μA). Also presented are preliminary data for a diode ion source where useful currents of many ion species, including O^-, Al^-, Cl^-, Cu^-, Bi^-, $(UF_n)^-$, have been obtained. A description of a negative ion injector specifically designed for the injection of high currents into tandem accelerators is outlined. (auth)

37362 HIGH VOLTAGE TECHNOLOGY. Denholm, A. S. (Ion Physics Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 780-91(June 1965).

Vacuum, high pressure gases and solid dielectrics, which are used extensively for the insulation of high voltages in particle accelerators, are discussed. Examples are given of high voltage technology applied to the acceleration of micron size particles and to the production of intense pulses of radiation of nanosecond duration. (auth)

37363 MATCHING AND ALIGNMENT FROM THE LINAC TO THE ZERO GRADIENT SYNCHROTRON. Crosbie, E. A.; Livdahl, P. V. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 799-803(June 1965).

The injection and matching system from the linac to the Argonne Zero Gradient Synchrotron is described in detail. Some theoretical matched solutions are shown. Practical methods for achieving a good beam into the ZGS are discussed. (auth)

37364 THE SLAC INJECTOR. Miller, Roger H.; Koontz, Roland F.; Tsang, David D. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 804-8(June 1965).

The injector for the Stanford Two-Mile Linear Accelerator was designed to achieve optimum bunching, optimum beam optics and flexible operational control of beam parameters. A test injector has achieved 5-degree bunching and 10^{-2}mc-cm area in the x-p_x plane. (auth)

37365 ELECTRON ATTACHMENT TO MEDIUM-ENERGY IONS. Sampson, M. B.; Eidson, W. W.; Bartis, F. J. (Indiana Univ., Bloomington). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 809-10(June 1965).

A method is proposed for changing the charge state of energetic ions such as are obtainable from medium-energy accelerators. The method consists of superimposing on the ion beam an electron beam of the same laboratory velocity. Thus, small center-of-mass velocities can be obtained even though large velocities are present in the laboratory system. The feasibility of the method was estimated from published cross sections for radiative recombination. The practicality of the method is being investigated in a simple experiment using 8.78 Mev alpha-particles from ThC' and 1.2 kev electrons. So far, no positive results are obtained, but this may be due to technical difficulties in superimposing the two beams, and/or the physical limitations imposed by space charge. Possible applications of this technique to future ion source and accelerator design are discussed. (auth)

37366 CYCLOTRON ION SOURCE TESTING FACILITY. Mallory, M. L.; Reiser, M. (Michigan State Univ., East Lansing). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 817-19(June 1965).

A facility was set up for development and testing of cyclotron ion sources with special emphasis on capability for rapid phase-space density measurements. Ions from the test source are accelerated into a 60 kv d–c dee and magnetically deflected thru 180°. A system of remotely adjustable slits are mounted inside the dee including: an adjustable slit directly behind the puller to define the radial width and position of the beam, a pair of adjustable slits located 90° from the puller, one defining the radial position, the other the vertical position of the beam and an adjustable current collecting probe located at 180°. In order to permit testing of sources for heavy ions, a considerably larger magnetic field was provided than is required for conventional sources (protons, deuterons, alphas). Ions with e/m ranging down to 1/30 can be deflected 180° with the dee potential at the full 60 kv; ions with lower e/m can be tested at reduced voltage. Polarities of both magnetic field and dee potential are reversible to allow convenient study of negative ion emission when desired. (auth)

37367 STABILIZED DC POWER SUPPLIES FOR BEAM INJECTION INTO ORBITAL ACCELERATORS. Reinhold, G.; Minkner, R. (Emile Haefely and Co. Ltd., Basel). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 820-3(June 1965).

Design considerations are presented for the 800 kv power supply of the preaccelerator for the 12.5 Bev Zero Gradient Synchrotron in operation at Argonne National Laboratory. (auth)

37368 FORMATION AND ACCELERATION OF NANOSECOND BEAM PULSES IN AN ISOCHRONOUS CYCLOTRON. Reiser, M.; Svanheden, A.; Howe, H. A. (Naval Radiological Defense Lab., San Francisco). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 824-9(June 1965).

Use of cyclotron beams for time-of-flight experiments requires the production of high-intensity ion bursts of very short time duration. A lower limit for obtaining short pulses of a defined energy spread is set by the intrinsic energy-time spread of the ion beam. The factors determining this spread are investigated. Central-region design features facilitating the formation of nanosecond pulses in the NRDL cyclotron are discussed, and results of detailed calculations on the magnitude of the intrinsic energy-time spread are presented. (auth)

37369 INJECTOR PULSER FOR LINAC PICOSECOND OPERATION. Hanst, R. K.; Norris, N. J. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 830-5(June 1965). (EGG–1183-2020)

An injection system is described which modulates the electron beam of the EG&G L-band linear accelerator for a time as short as one r–f period. Thus modulated, the accelerated electrons are further grouped into a bunch about 40 picoseconds long. The injected pulse is synchronized with the microwave frequency, producing constant, repetitive beam pulses. The measured pulse width is 100 picoseconds, determined by the response of the sampling oscilloscope. (auth)

37370 A 475.76 MHz LINAC CHOPPER. Nicholls, Gilbert L.; Voss, Gustav-Adolf (Cambridge Electron Accelerator, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 836-41(June 1965).

The Cambridge Electron Accelerator uses an S band (2854.56 MHz) linac as an injector, and a UHF (475.70 MHz) synchrotron r–f acceleration system. A chopper is used to eliminate five out of the six linac bunches, and the sixth bunch can be injected at the optimum phase with respect to the synchrotron r–f voltage. This reduces synchrotron oscillation, and reduces beam loading on the r–f, thus allowing for much larger accelerated currents. The linac uses constant phase velocity waveguides ($v_p = c$). The energy of the electrons introduced into the linac determines the trapping efficiency and the phase angle of the electron bunch with respect to the linac traveling wave. The chopper, situated between the gun and the linac waveguide, is a cylindrical 475.76 MHz cavity operating in the TM_{010} mode. It provides one half of the injection voltage (70 kv) for the selected electrons. The other half is provided by the gun pulse. Besides increasing the synchrotron intensity, the chopper system produced many other additional benefits. (auth)

37371 A 45° INFLECTION SYSTEM FOR THE STANFORD TWO-MILE ACCELERATOR. Herrmannsfeldt, W. B.; Miller, R. H. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 842-5(June 1965).

A 45° inflector for the off-axis injectors is described. The system features second-order isochronous corrections to preserve accelerator bunch length. The correction is made with a combination sextupole-quadrupole, the design for which is also included. (auth)

37372 TRANSPORT SYSTEMS FOR HIGH INTENSITY BEAMS. Taylor, Richard E. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 846-55(June 1965).

High intensities pose new problems in the design of transport systems. Induced radioactivity, radiation damage to materials, radiation induced chemical reactions, and heating problems are discussed. Proposed solutions to these problems for the Stanford linear accelerator transport systems in the beam switchyard are outlined. (auth)

37373 THE CAMBRIDGE ELECTRON ACCELERATOR BEAM POSITION MONITORS. Law, L. A.; Holcomb, L. (Harvard Univ., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 856-61(June 1965).

Electromagnetic beam monitors were developed and used to measure the position of the center of charge of the electron beam in the Cambridge electron accelerator. Wideband (10 MHz) and narrow band (18 KHz) monitors are used, having sensitivities of 1.75 μa/ma inch and 0.472 ma/ma inch, and minimum detectable signals of 0.29 ma. inch and 0.1μa inch respectively. (auth)

37374 POSITION MONITORING ELECTRONICS FOR THE STANFORD LINEAR ACCELERATOR. Larsen, Raymond S.; Woods, Hugh A. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 862-6(June 1965).

The overall beam steering system and the design requirements for the position monitoring electronics at the 30 sectors of the accelerator are outlined. The operation of the electronics is explained, and the more interesting circuits are described in detail. The performance is summarized. (auth)

37375 WATER COOLED BEAM DUMPS AND COLLIMATORS FOR THE STANFORD LINEAR ACCELERATOR.

Walz, D. R.; Jurow, J.; Garwin, E. L. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 867-71(June 1965).

Recent developments of power absorbing devices such as beam dumps, slits, and collimators are considered. A brief discussion is given of the heat transfer experiments that have been conducted at the Stanford Linear Accelerator Center to establish design heat flux conditions for the various materials to be used for the power absorbing devices. Design concepts of a 2.2 Mw, 11 to 25 Bev beam dump, as presently being built at SLAC, are also discussed. Finally, there is a typical analysis which leads to the design of a collimator, with emphasis on beam definition, heat transfer, thermal stress development and material selection. (auth)

37376 EXPERIMENTAL AREA BEAMS FROM THE ANL 12.5 Bev PROTON SYNCHROTRON. Ratner, L. G.; Crewe, A.; George, R.; Teng, L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 877-81(June 1965).

The picture frame magnet design, the double vacuum system and the use of tuning magnets at injection have elicited some unique features in the production of beams for the experimental areas of the ZGS. For the external proton beam, the basic method of extraction is similar to other proton synchrotrons in that an energy-loss target is used to displace the circulating beam. However, the design of the ZGS is such that the necessity for plunging extraction magnets into the aperture has been eliminated. Further, the design of these nonplunging magnets is such that they are operable at a fixed field and thus eliminate the need for complicated pulsing and timing systems. Measurements were made using various techniques, including scintillators and TV storage systems, polaroid film, secondary emission detectors, and radioactive foil analyses. For beams from internal targets, it is desirable to produce beams with various production angles, as well as being able to achieve zero degree production. It was found possible to establish three secondary beam channels looking at a common target point near the end of an octant. This point is in a nearly field-free region so that the channel angle becomes the production angle for both positive and negative particles. It is of interest that the construction of the ZGS is such that there is practically no fringe field beyond the octant edges. Furthermore, it was found possible to run targets into the octant along the inner vacuum chamber sidewalls without interfering with the injected beam. Orbits to the field-free point were calculated such that a range of momenta and production angles is transmitted through the three secondary beam channels. (auth)

37377 EXTRACTED AND SECONDARY BEAM TARGETRY. Marcks, Donald F.; Wehrle, Robert B. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 887-94(June 1965).

Meson target manipulators are used to remotely plunge targets anywhere within a 32 in. × 60 in. × 3 in. targeting volume inside the circulating beam chamber of the Argonne Zero Gradient Synchrotron. The mesons produced are of different momentum and enter three separate beam tubes from a single crossover point. Two mesons target manipulators normally position the targets for multitargeting of a single synchrotron beam pulse. The speed of targeting permits the r−f to move the beam pulse to extract two meson beams of different momentum. Using a shaped two-step command function, a single target is moved swiftly into two distinct positions, again extracting two meson beams of different momentum. Targets, target angles, target positions, and the target manipulators are changed without losing beam chamber vacuum. Fixed point meson targeting mechanisms are used for extended experiments that require only single presurveyed positions. Unique electrical linear actuators drive energy loss targets vertically for fast or slow proton extraction. Such fast drive modules are easily removed without interruption of the beam chamber vacuum. Numerous economical drive units with presurveyed targets are held on standby for quick change into the accelerator. A periscope television apparatus permits remote observation of all targetry for accuracy of position under vacuum. (auth)

37378 A HIGH INTENSITY, HIGH ENERGY MUON BEAM AT THE BROOKHAVEN AGS. Birnbaum, David; Tinlot, John; Yamanouchi, Taiji (Univ. of Rochester, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 895-8(June 1965).

Some preliminary results for the design of a muon beam of energy 2.5 Bev are presented, and some of the problems associated with such a design are discussed. (auth)

37379 DESIGN OF A TRANSPORT SYSTEM FOR HIGH INTENSITY BEAMS. Passner, A.; Powers, R.; Catura, R. C. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 912-16(June 1965).

A system was designed which is calculated to be capable of transporting up to 50 mA of 3 Mev protons a distance of seventy-five feet. The beam is contained within a radius of one inch and its phase plot is optimally matched to the acceptance of the synchrotron. This phase matching is accomplished over a wide range of beam currents by varying the excitation of the final quadrupole doublet. A computer program written to calculate the dynamics of the beam is described and some of its characteristics are discussed. (auth)

37380 THE NRL CYCLOTRON ION OPTICS SYSTEM. Shapiro, P.; Theus, R. B.; Frame, J. M. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 917-21(June 1965).

A 9 foot radius, 135 degree, double focusing magnet, having a second order energy resolution less than 2×10^{-4} for 1 mm slits, is the principal element in the NRL cyclotron ion optics system. A 21.5 inch wide pole face and 4.75 inch gap provide radial and axial acceptance angles of 3.0 degrees and 1.3 degrees respectively. This 80 ton magnet can be remotely traversed on a tracking system making it possible to bring the energy-analyzed beam into either of two experimental vaults for use along eight different beam paths. Also described is the coupling of quadrupoles with the analyzing magnet in a manner that provides a minimum dispersion system when the full cyclotron beam intensity is desired on the experimental target. Ray-tracing calculations were performed to determine the properties of the composite ion optics system, and the influence on image quality of power supply fluctuations and quadrupole misalignment. The design criteria for the system, the calculational methods used in the ray-tracing programs, and the results of ray-tracing along typical paths are discussed. (auth)

37381 THE MAGNETIC SHIELDING SYSTEM FOR THE STANFORD TWO-MILE ACCELERATOR. Herrmannsfeldt, W. B. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 929-30(June 1965).

The magnetic shielding system for the Stanford two-mile accelerator consists of a 0.006-inch-thick layer of high quality commercial magnetic shielding material wrapped around the accelerator. It is surrounded by a system of degaussing wires, consisting of two orthogonal sets of four wires spaced to provide uniform fields to cancel the vertical and transverse horizontal components of the earth's magnetic field. (auth)

37382 THE EXTERNAL ELECTRON BEAM FACILITY AT THE CAMBRIDGE ELECTRON ACCELERATOR. Paterson, James M. (Cambridge Electron Accelerator, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 931-4(June 1965).

The development of the resonant extraction technique has made possible the slow extraction of the internal beam from alternating gradient synchrotrons. An electron beam was extracted from the 6 Bev Cambridge electron accelerator in 1963, using this technique. Measurements of intensity and emittance confirmed the design calculations on the components of the extraction system. During 1964, the

external beam facility was developed to a point where it is in routine use for high energy physics experiments. Some modifications were made to the components of the extraction system and a more complete study was made of its performance. Seventy per cent of the circulating beam is extracted with spill times up to 1 millisecond. Two beams are derived from the extracted beam and are transported by achromatic transport systems to different points on the experimental floor. Each transport system was designed in such a way as to minimize the radiation hazard which could be produced by the intense electron beam. (auth)

37383 PRODUCTION OF STOPPED PIONS AND MUONS FROM A MULTI-Bev PROTON SYNCHROTRON. Hughes, V. W.; Edge, R. D. (Yale Univ., New Haven). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 943-8(June 1965).

The use of a multi-Bev synchrotron as a high intensity source of stopped pions and muons is discussed. To produce stopped pions extraction of pions at a relatively low energy between 100 and 200 Mev is necessary due to pion absorption in the attenuator used to stop the pions. Although no experimental data appear to be available on the cross section for production of such low energy pions by multi-Bev protons, experimental data on the production of higher energy pions can be used together with an empirical formula for the pion energy spectrum to estimate that the production cross section for 200 Mev positive or negative pions by 30 Bev protons is about 50 μb/sr/Mev/^{9}Be nucleus at a laboratory angle of 5°. Using such a cross section and considering other relevant factors it is concluded that the proton linac accelerator meson factory operating at 500 Mev with 6×10^{15} protons/sec will produce about 100 times as many stopped pions or muons as could be obtained in practice from the Brookhaven National Laboratory Alternating Gradient Synchrotron operating with an increased intensity of 2×10^{13} protons/sec. (auth)

37384 REMOVAL OF THE RF MICROSTRUCTURE FROM A PROTON LINEAR ACCELERATOR BEAM. Edge, R. D.; Hughes, V. W.; Sandweiss, J. (Yale Univ., New Haven). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 949-53(June 1965).

The r−f microstructure in the primary proton beam of a proton linear accelerator may consist typically of 0.2ns pulses spaced by 5 ns. This pulsed time structure can be removed to obtain a higher effective duty factor for the proton beam by utilizing the transverse phase space occupied by the beam. An anisochronous beam transport system can produce debunching. One such system consists of a sector magnet with a strong field gradient which bends the beam through 45° and fans it out. A second magnet, of uniform field, bends it through 90°, and a third magnet, identical with the first, recombines the beam and renders it again parallel. The r−f microstructure has now been removed, since protons from one side of the beam have travelled farther than the protons from the other side of the beam. Removal of the r−f microstructure in the secondary meson beams could be accomplished with a magnet system similar to but smaller than that for the proton beam. For a sector-focused cyclotron the above scheme for removing the r−f microstructure would require an excessively large magnet system. (auth)

37385 CURRENT STRIP FOR EXTRACTION OF THE CEA EXTERNAL ELECTRON BEAM. Burr, Paul H. (Harvard Univ., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 954-6(June 1965).

The method that is employed for extraction of 6 Bev electrons at the Cambridge Electron Accelerator is briefly described. The major element is a current strip, situated close to the orbit inner radius, which acts both as a nonlinear focusing element and a magnetic deflector. Major characteristics of the current strip are: long pulse, 60 cycle, 6 Bev operation with an rms current density of 56,000 amperes per square inch at a maximum temperature of 135°F; minimum susceptibility to radiation damage, mechanical distortion and gas evolution; and reproducible remote positioning. As a result of experiments carried out with this current strip, modifications are under consideration which would make the extraction of other beams practicable, and would eliminate the need for a supportive downstream extraction magnet. A brief discussion of the modifications is included. (auth)

37386 BEAM SWITCHYARD INSTRUMENTATION FOR THE STANFORD TWO-MILE ACCELERATOR. Neet, D. A. G. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 957-61 (June 1965).

A review is made of some engineering aspects regarding the construction of instrumentation for the high power beam transport system in the beam switchyard of the Stanford Linear Accelerator Center. A small control computer system is described that will be used for handling of data and for setting up the magnet systems in a quick and reproducible way. (auth)

37387 THE RF TRAVELLING WAVE PARTICLE DEFLECTOR. Gallagher, W. J. (High Voltage Engineering Corp., Walnut Creek, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 965-8 (June 1965).

The use of a travelling wave interaction as an improvement on existing cavity deflectors is suggested. The specific structure proposed was the use of the TM11-like mode in disc-loaded waveguide. The principle on which the separator functions is the production of a deflecting force, resulting from field components of a wave travelling synchronously with the particle beam. A beam transport system, appropriate to the experimental arrangement, permits observation of the differentiated particles. It can be shown that the motion of a particle interacting with a propagating wave at the velocity of light is characterized by uniform, aberrationless deflection over the beam aperture. The experimentally determined properties of such a waveguide (transverse shunt impedance, group velocity and solutions of the determinantal equation) are presented for the $\pi/2$-mode of propagation. A measurement technique for determining the shunt impedance, based on a perturbation method, is also discussed. (auth)

37388 MANIPULATION OF THE ZGS BEAM FOR TARGETING. Martin, J.; Dinkel, J.; Klaisner, L.; Varga, H. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 969-72(June 1965).

The feeding of as many as four experimental areas from a single ZGS pulse calls for a flexible system for controlling the spill of the beam. The beam is displaced radially into as many as four targets plunged into position after radial damping of the beam has occurred. Beam spills have been adjusted in time duration from 5 microseconds to 500 milliseconds during a flat-top period of the main magnet cycle. Spills shorter than about 0.5 millisecond are accomplished by a pulsed magnetic bump which displaces the orbit center. Spills longer than about 0.2 millisecond are accomplished by programmed adjustment of the accelerating r−f so as to expand or contract the orbit radius. Radiation level monitors in the vicinity of the targets or in the experimental beam lines are used to feed back a signal into the r−f program which results in the reduction of spill irregularities due to main magnet ripple and other noises. Such a spill has r−f structure and is on from 25% to 50% of the time. The repeatability for placing the beam into a given position for targeting is about 0.01 inch without employing feedback from radiation level monitors. A description of the equipment and instrumentation is given along with the performance. (auth)

37389 EXCITATION OF RADIAL OSCILLATIONS IN THE BEAM OF THE SYNCHROCYCLOTRON BY THE PERIPHERAL CEE. Nordberg, Emery (Univ. of Rochester, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 973-6(June 1965).

Measurements of the characteristics of operation of the University of Rochester peripheral Cee show that the Cee

may be used not only in the normal manner to stochastically accelerate the internal beam but also in a manner which induces radial oscillations in the coasting beam. These measurements verify the proposal of Wormald by fitting the Dee cutoff frequency, the Cee frequency and the magnetic field gradient to the well known function for radial oscillations in a cyclotron. Other evidence for this regenerative mode of operation is the fact that the energy of a polarized proton beam obtained by scattering the internal beam from a carbon target is reduced by an amount determined by the Dee cutoff frequency, and that its energy spread is also reduced. The pion beam intensity obtained when the Cee is operated in this regenerative mode is nearly independent of the voltage on the Cee whereas in the accelerating mode it is approximately linearly dependent on the voltage. Details of the characteristics of operation are presented. (auth)

37390 BEAM PULSE SELECTOR FOR A SECTOR FOCUSED CYCLOTRON. Svanheden, A.; Howe, H. A.; Reiser, M. (Naval Radiological Defense Lab., San Francisco). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 977-9(June 1965).

For the U. S. Naval Radiological Defense Laboratory's (NRDL) 70-inch sector-focused cyclotron a beam-pulse selector system has been developed by means of which an individual beam pulse or fish can be selected near the center of the machine and then accelerated to full energy and extraction. The beam is normally deflected axially into a beam stopper by a negative d–c voltage of 10.5 kv applied to the deflector plates via a helically wound coaxial line of 2000 ohms characteristic impedance. An individual fish is transmitted by applying a 5.5 kv positive pulse of less than 40 nsec duration at the input of the coaxial line. (auth)

37391 BEAM SCANNER FOR THE OXFORD ELECTROSTATIC TANDEM ACCELERATOR. Takacs, J. (Oxford Univ.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 980-4(June 1965).

Detailed description of a new design used at Oxford for scanning the beam profile is given. The main drawback of some other beam scanners of having rotating components and bearings in vacuum is eliminated. The electromagnetically driven wire vibrates at 20 c/sec and crosses the beam parallel to X and Y axes. The simplicity and small size makes possible its use anywhere on the beam lines. The display unit which is centrally placed in the control room can be switched to any beam scanner so the operator can check the condition of the beam at all the important points. Circuit diagrams for the driver, head amplifier and also the display unit are given. Test results obtained on the Oxford Tandem Accelerator are presented. (auth)

37392 SECTORED CYCLOTRONS. Blosser, H. G. (Michigan State Univ., East Lansing). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 985-95(June 1965).

Conventional fixed frequency cyclotrons evolved from the pioneering work of E. O. Lawrence and M. S. Livingston; typical performance characteristics include fixed output energy, fixed e/m of the accelerated ions, energy less than 10 Mev/nucleon, poor beam quality and poor duty cycle. In recent years a series of new concepts have revolutionized the fixed frequency cyclotron. These new concepts include sector focusing, variable frequency r–f systems, resonant extraction, programmed orbits, and acceleration of negative ions. The resulting machines, referred to herein as sectored cyclotrons, have essentially ideal properties as compared with the classical cyclotron, i.e., variable energy, variable e/m, arbitrary final energy, good beam quality, and greatly improved duty cycle. The fundamentals of modern sectored cyclotrons are reviewed with illustrative examples drawn from the present generation of such machines; the possible features and design problems of future machines of this type are considered. (auth)

37393 HIGH CURRENT TRAVELING WAVE ELECTRON LINEAR ACCELERATORS. Haimson, J. (Varian Associates, Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 996-1011(June 1965).

The steady state and stored energy operational regimes of microwave electron linear accelerators are discussed with reference to high current capability. Avoidance of the beam blow-up pulse shortening phenomenon enables long pulse beam currents considerably greater than the maximum conversion efficiency value to be demonstrated. Heavy beam loading effects and choice of frequency are discussed with respect to this steady state operation, and it is shown that conversion efficiencies of greater than 90 per cent can be readily achieved. Stored energy considerations indicate that an increase in peak current of one or two orders of magnitude may be achieved for pulses of short duration with relatively conventional accelerator waveguides. Electron orbit theory including space charge effects for this transient condition is developed. Some experimental data obtained with a 10 Mev linear accelerator using a short pulse inflection system is presented. A concluding discussion deals with design criteria for stored energy operation in high power traveling wave structures and encourages further exploitation by providing higher current high potential sources capable of prebuncher or r–f chopped short pulse injection. (auth)

37394 MESON FACTORIES. Richardson, J. Reginald (Univ. of California, Los Angeles). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 1012-26(June 1965).

Meson factories are those accelerators designed to produce beams of protons in the energy range of 400 to 1000 Mev with intensities at least 1000 times greater than those presently available from FM cyclotrons. They have an important role in future research in nuclear structure physics, elementary particle physics, and bio-medical research. The criteria for selection of a meson factory are discussed. They include duty factor and the time structure of the beam, the possibility of varying the energy of the beam, the efficiency with which a large fraction of the beam can be brought to an experimental area, the possibility of the simultaneous use of high duty factor beams of differing energy, the amount of radioactivity induced in the accelerator, and general flexibility. Additional criteria are cost and the relative difficulty of the expected technological problems. Descriptions are given of the various types of accelerators which have been seriously suggested for this role. These include the sector-focusing cyclotron for the acceleration of positive ions, the sector-focusing cyclotron for the acceleration of negative hydrogen ions, and the sector-focusing ring cyclotron. The linear accelerator for the acceleration of protons has also been suggested as a meson factory, and the final description concerns the separated orbit cyclotron, combining some of the features of the linear accelerator and the sector focusing cyclotron. An attempt is made to use the criteria in a comparison of the promise of these various types of accelerators in the role of meson factory. (auth)

37395 THE FUTURE OF ELECTRON SYNCHROTRONS. Livingston, M. Stanley (Cambridge Electron Accelerator, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 1027-32(June 1965).

The electron synchrotron has become a highly successful instrument for high-energy physics with the application of alternating gradient focusing. Development toward large orbits and low magnetic fields has brought the problem of radiation loss under control and has stimulated design planning for very high energies. The magnets can be powered at high cycling rates (60 cps) by resonant electrical circuits. The most valuable feature is the long duty cycle available for experiments, of up to 20% of total time. Photons emerge tangentially in sharply collimated beams from targets at the edge of the orbit. Emergent beams of electrons can be ejected with high efficiency, having small energy spread and excellent collimation. Future developments should bring higher beam intensities as well as higher energies. Positrons can be accelerated in the same orbit, with reversed magnetic fields and a suitable source. The AG magnet system should distribute the damping due to synchrotron radiation between radial, vertical and synchronous modes, as in a storage ring. In principle, particles

could be injected in each cycle and stored to develop high-intensity circulating beams. With orbits as large as the giant AG proton synchrotrons of the future, electron energies of 50 Bev or higher could be obtained. A large fraction of the orbit would be filled with r–f accelerating cavities spaced between the AG magnet units, powered in phase as in a linac. As for all large-orbit machines the major cost would be for buildings, tunnels and services. (auth)

37396 RECENT DEVELOPMENTS ON THE STANFORD 500 Mev ELECTRON STORAGE RINGS. Gittelman, Bernard (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 1033-41(June 1965).

Large angle electron scattering was detected on the Stanford storage rings. The operation of the rings is now adequate to proceed with the proposed test of quantum electrodynamics. A discussion of the event rate and possible limitations on this rate is given. (auth)

37397 SUPERCONDUCTING ACCELERATORS. Wilson, P. B.; Schwettman, H. A. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 1045-52(June 1965).

The application of superconductivity to several devices which conventionally require large amounts of r–f power is considered. Design characteristics are given for superconducting electron linacs, cavities for electron synchrotrons, r–f separators and microtrons. (auth)

37398 CALCULATION OF THE ACCELERATING ELECTRIC FIELD OF THE SYNCHROCYCLOTRON. Enchevich, I. B.; Penchev, G. I.; Safonov, A. N. Izv. Fiz. Inst. s Aneb, Bulgar, Akad. Nauk, 13: 111-30(1965). (In Bulgarian)

By solving the Christoffel-Schwartz integral, the formulas for calculating the electric field of the synchrocyclotron dee were obtained in the absence of the ion source and the dummy dee. Two variants of the calculation are compared: taking into account the effect of the vertical wall of the accelerating chamber opposite the dee and without taking it into account. The calculation has shown that even in the case when the effect of the vertical wall on the electric field distribution is strongest, the difference of the coordinate values for the equipotentials most remote from the dee (0.005) is observed only in the seventh significant digit. Consequently, for calculating the dee electric field the formulas deduced without taking into account the chamber vertical wall should be used, since in this case the calculation is less laborious. The calculation of the dee potential field for the dee aperture h = 12 cm and some values of the accelerating chamber aperture (H = 15, 16, 18, 36, 48, 60 cm) was performed by means of the formulas. The results are given in the form of diagrams of equipotential lines and a table containing the value of the potential and the dee electric field strength in the median plane. The dependence of the maximum energy gain per turn upon the radius is calculated, since this parameter is of importance in analyzing the phase motion of ions. As the calculation of the dee electric field was carried out without taking into account the effect of the ion source plasma column on the field distribution, the formulas obtained should be used in considering ion motion when the process of their capture into acceleration is over and the ion source is switched off. (auth)

37399 ACCELERATION OF POLARIZED PROTONS AND DEUTERONS IN A TANDEM ACCELERATOR. Haeberli, W.; Gruebler, W.; Extermann, P.; Schwandt, P. (Univ. of Wisconsin, Madison). Phys. Rev. Letters, 15: 267-8(Aug. 9, 1965).

Negative deuterium ions were produced by passing a 50-kev beam of polarized deuterons through a carbon foil of about 10 $\mu g/cm^2$ thickness. The negative beam was momentum analyzed in a 12° bending magnet and injected into a 12 Mev tandem accelerator. The polarization of the beam was measured by observing the anisotropy of protons from the reaction $^3He(d,p)^4He$. The results showed that the polarization is less than the calculated value by a factor of 2.5. When protons were accelerated the observed beam polarization was 0.17 ± 0.02, while the largest proton polarization that can be produced by a source of the type used is 0.5. Proton-alpha scattering was used to measure the polarization of the protons. When the gas stripper was replaced by a thin carbon foil no depolarization seemed to occur within an accuracy of about ±10%. It is presumed that the depolarization can be removed by applying a magnetic field. Also successive pickup and removal of electrons when protons move through low-density matter is thought to be an important depolarization process. (J.F.P.)

37400 ELECTRON BEAM MAXIMUM CURRENT PROVIDED THE SPACE CHARGE HAS CONSTANT DENSITY. Bakhrakh, L. E. Radiotekhn. i Elektron., 10: 1104-9 (June 1965). (In Russian)

The influence of transverse distribution of potential on the behavior of the band current, cylindrical beams, and band beam boundary diffusion was analyzed assuming that the space charge has constant density across the electron beam cross section. (tr-auth)

37401 A BETATRON WITH SPIRAL ACCUMULATION OF ELECTRONS. Abramyan, E. A.; Budker, G. I.; Glagolev, G. B.; Naumov, A. A. Zh. Tekhn. Fiz., 35: 605-11(Apr. 1965). (In Russian)

The B2 accelerator of the Kurchatov Atomic Energy Institute is described, and experiments performed with it from 1955 to 1957 for the purpose of obtaining large circulating currents are reported. The equipment has since been modified and is now used as an injector for a larger accelerator. The B2 accelerator was a small betatron employing the spiral space-charge accumulation system proposed by Budker and Naumov and by Hund. The fields in the central core and in the acceleration chamber were produced by separate windings. In the initial stages of the cycle electrons were continuously injected near the inner wall of the chamber, while the magnetic field in the chamber was held constant and that in the central core was increased. This resulted in the acceleration chamber becoming filled with electrons in various stages of acceleration. Subsequently both fields were increased and the electrons were collected in the vicinity of an equilibrium orbit. The highest energy reached was 5.6 Mev in a 1.5 × 1.5 cm^2 bundle in the vicinity of a 40 cm radius equilibrium orbit. A current of 75 amp of 2.8-Mev electrons was obtained near a 14 cm radius equilibrium orbit. The theory of the accelerator is developed, and electron trajectories are calculated. It is shown that the attainable charge density is limited by the defocusing effect of the space charge. The experimental results were found to be in good agreement with the theoretical predictions, and it is concluded that the spiral electron accumulation system is practical. (ATD)

37402 A PULSED IRON-FREE SYNCHROTRON. Abramyan, E. A.; Bender, I. E.; Budker, G. I.; Kadymov, A. Kh.; Naumov, A. A.; Panasyuk, V. S. Zh. Tekhn. Fiz., 35: 612-17(Apr. 1965). (In Russian).

An iron-free synchrotron featuring the use of a single-turn shaped-conductor magnet under conditions in which the skin depth was small compared with the dimensions of the apparatus is described. Electrons were injected at 50 kev, were accelerated by betatron action to 2 Mev, and were subsequently accelerated with the instrument operating as a synchrotron. The instrument was designed to produce 200-Mev electrons in a magnetic field of 38 kgauss. When the experiments were discontinued in 1957 in favor of work with a different model, 70-Mev electrons had been produced. The experience with the accelerator confirmed the principles on which it was based and, in particular, showed that it is possible to produce a magnetic field of given form with great accuracy by means of shaped conductors under conditions of small skin depth. (ATD)

37403 ON HIGH-FREQUENCY FOCUSING IN LINEAR ACCELERATORS. Makhenko, L. A.; Pakhomov, V. I.; Stepanov, K. N. Zh. Tekhn. Fiz., 35: 618-22(Apr. 1965). (In Russian)

The focusing effect in a traveling-wave linear accelerator of a reflected wave propagating in the opposite direction

to the electron motion is calculated. The reflected wave is found to improve the focus both with respect to phase and with respect to radial motion. The improvement in phase stability is shown to be negligible in the relativistic case and to be significant in the nonrelativistic case only when the equilibrium phase is close to $\pi/2$. The radial focusing is improved at all energies. The radial focusing effect of the backward traveling wave is equivalent to that of a uniform longitudinal magnetic field of which the strength is of the order of the wave amplitude. The radial focusing effect was verified experimentally by directing a divergent beam (divergence angle 0.001 rad) of 5-Mev electrons down a 3.6 m long septate waveguide. When a wave of amplitude 56 kv/cm was directed up the waveguide, the average current increased by a factor 1.8. There was no accelerating wave traveling down the waveguide in these experiments. (ATD)

37404 PARTICLE BEAM INTENSITY STABILIZATION IN THE OIYaI SYNCHROPHASOTRON. Kazanskii, G. S.; Mikhailov, A. I.; Tsarenkov, A. P. Zh. Tekhn. Fiz., 35: 623-9(Apr. 1965). (In Russian)

The means employed for stabilizing the proton dose per pulse on the experimental target when working with the 10-Bev synchrophasotron of the Joint Institute for Nuclear Research are discussed. The beam is extracted by programmed variation of the amplitude, frequency, and phase of the high-frequency accelerating potential. Stabilization is effected by one of two general methods, depending on the nature of the experiments. In stabilization "from below" a signal proportional to the decreasing intensity of the primary proton beam produces a pulse, when it reaches a predetermined level, which interrupts the process of changing the intensity of the primary beam. The excess beam is either wasted or directed to another experiment. In stabilization "from above" the beam is monitored at the experimental target itself. The automatic monitoring and beam switching system makes it possible to direct portions of the beam to several experimental targets during each acceleration cycle. A brief theoretical discussion is given of the operation of the control system. It is concluded that a stability of 10% for small intensities can be achieved only by preliminary stabilization of the intermediate intensities, that inequalities in the extraction due to nonuniformity of the particle bunch and ripple in the magnetic field strength have a significant influence, and that delays in the control circuits must be minimized. (ATD)

37405 THE TOROTRON, AN INDUCTION ELECTRON ACCELERATOR. Moskalev, V. A. Zh. Tekhn. Fiz., 35: 630-4(Apr. 1965). (In Russian)

An induction electron accelerator is proposed in which a rising current in a winding produces a toroidal magnetic field within a toroidal enclosure containing a toroidal ferromagnetic core. Electrons injected around the periphery are accelerated by betatron action and execute toroidal orbits. Drift of the electrons in the toroidal magnetic field is suppressed by applying an appropriate potential difference between the core and the wall of the chamber. At the end of the acceleration period, the electrons strike a ring-shaped target, producing bremsstrahlung which is focused on a point on the axis, where materials to be investigated or patients to be treated may be placed. The theory of the accelerator and the feasibility of its construction are discussed briefly. It is concluded that much greater currents can be obtained with a torotron than with a betatron, that the torotron is much simpler than a linear accelerator, and that the torotron is much smaller and lighter than the high-current induction accelerator of Christofilos. (ATD)

37406 INVESTIGATION OF A LINEAR INDUCTION ACCELERATOR. Lutsenko, E. I.; Bolotin, L. I.; Fainberg, Ya. B.; Kharchenko, I. F. Zh. Tekhn. Fiz., 35: 635-42(Apr. 1965). (In Russian)

The behavior of a "linear plasma betatron" was investigated. The apparatus consisted of a 100 cm long, 4 cm diameter glass discharge tube surrounded for 60 cm of its length by 12 toroidal iron cores each bearing a single copper turn. Plasma was produced in the discharge tube by high-frequency discharges between electrodes at the ends, and a 25-kv, 0.6-μfd capacitor was discharged through the copper turns. The "run away" electrons accelerated by the induced electric field were the principal object of study. The mean energy of the "run away" electrons was found to be considerably less than should be expected from the strength of the accelerating field. Plasma polarization and instability effects were sought to account for this reduced electron energy, and both were found. The plasma polarization was detected by observing with an oscilloscope the signal from external electrodes near the ends of the discharge tube, and development of plasma instability was followed by measuring the radiation from the oscillating plasma in the microwave region. Under some conditions accelerated electrons were observed traveling in the backward direction. It is suggested that these may result from a pinch effect, but further experiments will be required for their elucidation. (ATD)

37407 INVESTIGATION OF THE ELECTRON BEAM FROM A RING GUN. Minenko, L. I.; Fomenko, G. P. Zh. Tekhn. Fiz., 35: 705-10(Apr. 1965). (In Russian)

A method of betatron injection is considered in which a hollow conical converging electron beam is used. The influence of space charge on the motion of the electrons in the region of the crossover is calculated, and results of measurements with an experimental beam are reported. The inner and outer diameters at the gun of the 1.6 and experimental beam of 10-kev electrons were 5.5 and 6.3 cm, respectively. The vertex angle of the conical beam was $2 \times 13°$, and the focus (cross-over) was accordingly 15 cm from the gun. Preliminary observation of the beam was performed with a movable fluorescent screen, and the current distribution was measured with a multiple collector. Information concerning the radial velocity distribution in the beam was obtained by examining the cross-section variation of the portion of the beam that passed through a 0.5 mm diameter aperture in a screen. It was found that when the space charge was sufficiently great the hollow conical converging beam became, after the crossover, a solid diverging beam with the maximum current density on the axis. Moderate discrepancies between theory and experiment are ascribed to the influence of ionized molecules of the residual gas, the pressure of which was $(1\text{-}3) \times 10^{-5}$ mm Hg. (ATD)

37408 INVESTIGATION OF PROPERTIES OF SUPERCONDUCTING RESONATORS AT A FREQUENCY OF 1100 MEGACYCLES. Sidorenko, I. S.; Revutskii, E. I. Zh. Tekhn. Fiz., 35: 748-50(Apr. 1965). (In Russian)

An investigation is made of the possibility of using an ordinary commercial lead as a material for the resonator of a particle accelerator. Preliminary results of tests at a frequency of 1100 Mc are summarized. Surface resistance, determined by measuring the resonator Q-factor (a function of the rise of induced oscillations and the attenuation time of free oscillations in the resonator), decreased by 6 to 7 orders of magnitude from the value at 300K (330) when the resonator was cooled down to 4.2K. The resonator, which consists of a section quarter-wave coaxial line, has a natural frequency of 1100 Mc. It can be used in accelerators in which the maximum magnetic field is less than 500 gauss. Such resonators can be used as tank circuits of master oscillators and as h-f filters for frequency stabilization. (ATD)

37409 SPHERICAL ABERRATION IN THE WIDTH OF A LINE IMAGE FORMED BY A COMBINED QUADRUPOLE LENS. Dymnikov, A. D.; Fishkova, T. Ya.; Yavor, S. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 35: 759-61(Apr. 1965). (In Russian)

A differential equation for the trajectory in a combined electrostatic and magnetic quadrupole lens is used to calculate the spherical aberration in the width of a line image. The spherical aberration in the converging plane is always positive, but outside this plane it may have either sign and depends on the relative excitation of the electrostatic and magnetic quadrupoles. Calculations for a thin lens with a bell-shaped field distribution on the axis show that the spherical aberration is positive over the entire length of the line image for a wide range of relative elec-

tric and magnetic excitations, including that for which the combined quadrupole is achromatic. In these calculations, it is necessary to include the second derivative of the field strength on the axis; Markovich and Tsukkerman and Strashkevich have obtained erroneous results by neglecting this term, while retaining other terms of higher order. The spherical aberration of the thin quadrupole lens is much less than that of an axially symmetric lens with the same axial field strength distribution. (ATD)

37410 THE "IMAGE" EFFECT IN BEAM ACCUMULATORS. Shukeilo, I. A. Zh. Tekhn. Fiz., 35: 905-9 (May 1965). (In Russian)

The effect of the conducting walls of the toroidal chamber on the motion of an intense beam of ultrarelativistic particles circulating in a weak-focusing cyclic accelerator or beam accumulator is calculated. The problem is simplified by neglecting the curvature of the beam and the effect of the side walls, and assuming the upper and lower walls to be perfectly conducting planes. Bunching of the beam is taken into account by expanding the charge, current, and fields in Fourier series. The field of the beam is calculated by means of an image method under the boundary conditions that the scalar potential and the normal component of the magnetic field vanish on the upper and lower walls of the chamber. The field thus calculated is used to obtain the equation for the betatron oscillations of the beam (which is again regarded as circular), and this equation is discussed very briefly. (ATD)

37411 STRONG-FOCUSING PROPERTIES OF A SYSTEM OF OPPOSING MAGNETIC FIELDS. Zakharov, V. S.; Rabinovich, M. S. (Moscow State Pedagogical Inst.). Zh. Tekhn. Fiz., 35: 910-13(May 1965). (In Russian)

The strong-focusing properties of a longitudinal magnetic field of alternating direction are discussed. The magnetic fields discussed are those described by a scalar potential of the $\Phi = \Sigma_{n=0}^{\infty} (h_{2n+1}/\alpha) I_0[(2n+1)\alpha\rho] \sin[(2n+1)\alpha R\theta]$, where r, θ, z are cylindrical coordinates, R is the radius of the equilibrium orbit, $\alpha = 2\pi/L$ where L/2 is the distance between successive windings in which the currents are in opposite directions, ρ is the distance from the equilibrium orbit, I_0 is the Bessel function of an imaginary argument, and the h is a constant. Only the first term of this expansion is employed in the calculations. A suitable guiding field with components in the z and r directions is superimposed, and calculations are also performed for the corrugated field obtained by superimposing a constant longitudinal (azimuthal) field. The frequencies of the betatron and synchrotron oscillations are calculated, and the corresponding phase volumes are estimated. It is found that the alternating and corrugated fields exert considerably stronger focusing action than a simple longitudinal field. Because of the simplicity of design, this type of focusing should find application to moderate energy synchrotrons and betatrons, particularly to iron-free accelerators and plasma betatrons. (ATD)

37412 NONLINEAR INVESTIGATION OF SPATIAL FOCUSING IN MAGNETIC FOCUSING PRISMS WITH INVERSE RADIUS FIELDS. Malov, A. F.; Suzdalev, V. A.; Fedoseev, E. P. Zh. Tekhn. Fiz., 35: 914-26(May 1965). (In Russian)

A detailed discussion is given of the electron optics of a magnetic prism consisting of a sector (bounded by circular arcs passing through the symmetry axis) of an axially symmetric magnetic field, the strength of which, in the plane of symmetry, is inversely proportional to the distance from the axis. Vertical focusing and imaging of an extended source are discussed in addition to horizontal focusing and imaging of point and line sources, and the equations are put into a form suitable for design computations. The effect of the fringe field is not treated. A model was constructed, and its fringe fields were measured. (ATD)

37413 THIRD ORDER ABERRATIONS IN THE WIDTH OF A LINEAR IMAGE FORMED BY A COMPOSITE QUADRUPOLE LENS. Ovsyannikova, L. P.; Yavor, S. Ya. (Leningrad Physico-Technical Inst.). Zh. Tekhn. Fiz., 35: 940-6(May 1965). (In Russian)

The third-order aberrations are calculated of a composite electrostatic and magnetic quadrupole lens in which the axial distributions of the electric and magnetic fields are described by the same distribution function, but in which the two fields may have different strengths. The third-order trajectory equations given by Dymnikov, Fishkova, and Yavor are solved by the variation of constants method, and the ten third-order aberration coefficients are calculated. The effect of a diaphragm is considered; and the aberrations are separated into spherical aberration, astigmatism, and field curvature, coma, and distortion. In spite of the presence of a magnetic field, there are no third-order anisotropic aberrations. Two simplified cases are discussed: that of a "two-dimensional" lens, in which the lens is infinitely long, containing the object and image planes within it, and the fields are uniform on the axis, and that of a thin lens. Six of the ten aberrations of a "two-dimensional" lens reduce in the case of a purely electrostatic lens to those given by Strashkevich, but four of them, relating to astigmatism and coma, do not. The discrepancy is due to errors in Strashkevich's calculations. In the case of a thin lens, all the third-order aberrations except spherical aberration can be made to vanish by placing the stop at the center of the lens and properly choosing the ratio of electric to magnetic field strength. (ATD)

37414 ACHROMATIC ELECTROMAGNETIC QUADRUPOLE LENSES WITH NONCOINCIDENT AXIAL FIELD DISTRIBUTIONS. [PART] 2. Shpak, E. V., Yavor, S. Ya. (Leningrad Physico-Technical Inst.). Zh. Tekhn. Fiz., 35: 947-50(May 1965). (In Russian)

The condition for achromaticity of the image position is calculated for a composite electrostatic and magnetic quadrupole lens in which both fields are rectangularly distributed on the axis but in which either the magnetic field extends farther along the axis than the electric field, or both fields have the same axial extent but are shifted axially with respect to each other. The achromaticity conditions are compared with that previously obtained for the case in which the electric field extends farther along the axis than the magnetic field. The theoretical achromaticity conditions were tested experimentally with a 20.7 cm-long, 6-cm aperture magnetic quadrupole lens and a 2.6-cm aperture electrostatic quadrupole lens of the same length consisting of a metal cylinder with 6-mm-wide slots cut on generatrices. By comparing the excitations of the two centered lenses required for achromaticity with the theoretical formula and using the previously determined form factor of the magnetic lens, the form factor of the electrostatic lens was determined; it was found to be within 2% of the value calculated on the assumption of infinitely narrow slots. The experimental achromaticity conditions for the shifted lenses were found to be in good agreement with the theoretical. When the achromaticity condition was fulfilled, the position of the image shifted by only 2% when the energy of the focused particles was changed from 5 to 7.5 kev; for a purely magnetic lens the corresponding image shift was 120% and 45% for an electrostatic lens. (ATD)

37415 NONLINEAR OSCILLATION PHASE STABILITY IN NONLINEAR FOCUSING ACCELERATORS. Orlov, Yu. F. pp 578-99 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian).

The rigorous theory of phase stability of one- and two-dimensional motion needed for the design of modern nonlinear focusing accelerators is given. It covers also two-dimensional stability without the use of external forces. The procedure for the basic design of an annular synchrocyclotron without resonance crossing is outlined. (CFSTI)

37416 ELEKTROFIZICHESKAYA APPARATURA. VYPUSK 3. (Electron-Physics Apparatus. Issue 3). Komar, E. G., ed. Moscow, Atomizdat, 1965. 152p.

Separate abstracts were prepared for thirteen of the seventeen papers included. The remaining papers deal with a titanium sputtering device, the interaction of fields

of coaxial solenoids, radiation effects on epoxies, and stabilization of a high-voltage power supply. (D.C.W.)

For abstracts of individual papers see: 36774, 36775, 36776, 37236, 37417, 37418, 37419, 37420, 37421, 37422, 37423, 37424, and 37425.

37417 SOME PROBLEMS OF DYNAMIC MOTION OF PARTICLES IN A CYCLOTRON WITH SPATIAL VARIATIONS OF MAGNETIC FIELD. Basargin, Yu. G.; Belov, V. P. p.3-24 of "Elektrofizicheskaya Apparatura. Vypusk 3." Moscow, Atomizdat, 1965. (In Russian).

Second-order equations are derived for the equilibrium orbit, period of rotation, and the betatron oscillation frequency for the constant-velocity motion of a particle in an isochronous cylotron. Azimuthal variations in the magnetic field are expanded in a few-term Fourier series. The retention of additional terms in the series improves accuracy, but requires a machine solution. The equations are simplified by ignoring terms which contain products of Fourier coefficients with dissimilar harmonics. Results of the original and simplified equations are compared for $(^{14}N)^{+4}$ at 2.6 to 52.7 Mev in a 3-sector cyclotron. Agreement is on the order of 0.5%. (TTT)

37418 USE OF INDUCTION COILS FOR MEASURING LOWER HARMONICS OF AZIMUTHAL HETEROGENEITIES IN MAGNETIC FIELD OF A SECTOR CYCLOTRON. Litunovskii, R. N. p.25-36 of "Elektrofizicheskaya Apparatura. Vypusk 3." Moscow, Atomizdat, 1965. (In Russian)

Variations in the magnetic field $H_z(r,\theta)$ in the cyclotron are measured by two induction coils placed at an angle with each other of $\Delta\theta = 2\pi/N$. The coils are connected so that the effect of the N-th harmonic is canceled from the total output signal. Errors in measuring ΔH_z are on the order of 1 gauss; the largest component of the error is the inability to reproduce the positioning of the coils in the magnet. (TTT)

37419 ACCELERATION SYSTEM OF 5 Mev LINEAR ELECTRON ACCELERATOR. Vyalitsyn, V. A.; Nadybin, A. I.; Prudnikov, I. A.; Ryabtsov, A. V.; Smirnov, V. L.; Khokhlov, V. K. p.37-45 of "Elektrofizicheskaya Apparatura. Vypusk 3." Moscow, Atomizdat, 1965. (In Russian)

The operating characteristics of an accelerator are described to produce 5-Mev electrons or gamma-rays for medical therapy purposes. The principal feature of the accelerator is a diaphragm waveguide with the length of the accelerating section continuously variable from 767 to 2200 mm. The accelerator could deliver 3.5-μsec pulses of electron at 100 mamp. Eighty percent of the injected electrons reach the target at the end of the accelerator. Energy resolution is better than 5%. The gamma dose is 600 r/min at a distance of 1 m from the end of the target. (TTT)

37420 PROBLEMS IN DEVELOPING A DEFLECTING SYSTEM FOR 5 Gev ANTIPROTON CHANNEL. Davydov, M. S.; Zeitlenok, G. A.; Levin, V. M.; Malyshev, I. F.; Petelin, I. G.; Petrunin, V. I.; Trushin, N. F.; Finkel'shtein, I. I. p.51-63 of "Elektrofizicheskaya Apparatura. Vypusk 3." Moscow, Atomizdat, 1965. (In Russian)

Even after an antiproton beam passes through a magnetic lens and collimating system, it contains a large number of mesons (π^-). The antiprotons and mesons (π^-) have the same momentum but different velocities, so that the antiprotons and mesons (π^-) can be separated by a high-frequency magnetic field. A 150-megacycle, 2.5-kv resonance system is described. The curved shape of the resonator chamber was chosen because it required less power than a rectangular chamber by a factor of 3.5. Sixteen electromagnetically decoupled chambers are used in a series with a cross section of 100×150 mm^2. The electric field in each resonator is 31.2 kv/cm. The system produced 6-msec pulses with a repetition rate of 5 pulses/min. (TTT)

37421 CALCULATIONS OF RADIOTECHNICAL PARAMETERS FOR POLYCYLINDRICAL RESONATORS. Krasnov, K. A.; Petelin, I. G. p.64-71 of "Elektrofizicheskaya Apparatura. Vypusk 3." Moscow, Atomizdat, 1965. (In Russian)

Equations are given for the power consumption, Q-value, wave resistance, shunt resistance, and decay length for a compensating resonator made up of concentric cylinders which are used to stabilize high-energy particle beams (on the order of 1 Bev). Sample calculations are given for resonators 10 to 30 m long. (TTT)

37422 CALCULATIONS OF ELECTRICAL STABILITY OF COMPLEX FORM RESONATORS. Petelin, I. G. p.72-5 of "Elektrofizicheskaya Apparatura. Vypusk 3." Moscow, Atomizdat, 1965. (In Russian)

A dimensionless method is presented for determining the critical voltage u_c that can be applied across a resonator before a discharge occurs. The critical voltage is given by $u_c = E_c\, d/K_\varnothing K_{hf}$, where E_c is the maximum allowable field at a given point of the resonator, and d is the distance between electrodes at that point. $K_{hf} = E_c/DE_{av}$, where E_{av} is the average field in the resonator; K_{hf} may easily be determined experimentally. The coefficient $K_\varnothing$ may be determined to within 10-20% from previously published curves that depend only on the ratios d/r_1 and r_2/r_1, where r_1 and r_2 are the radii of curvature. (TTT)

37423 MEASUREMENTS OF THE MEAN MAGNETIC FIELD POSITION IN ELECTROMAGNET OF 70 Bev ACCELERATOR. Veselov, M. D.; Gerbovetskii, V. M.; Mozin, I. V. p.106-10 of "Elektrofizicheskaya Apparatura. Vypusk 3." Moscow, Atomizdat, 1965. (In Russian)

The electromagnet consists of blocks, each of which contains 5 coils. The position of the average magnetic surface was determined by measuring the radial component of the field of each coil with a permalloy probe and comparing the results with data from a standard coil. The apparatus and electronics are described in detail. The position of the probe could be determined to within ±0.05 mm, and the field could be determined to ±0.005 gauss. The position of the average magnetic surface in each coil was determined to within 0.24 mm. (TTT)

37424 TRIGGERING A PARALLEL ION INVERTER IN A RESONANCE CIRCUIT. Gusev, O. A.; Nechaev, A. G.; Tsvetkov, V. G. p.138-44 of "Elektrofizicheskaya Apparatura. Vypusk 3." Moscow, Atomizdat, 1965. (In Russian)

Three methods are discussed for triggering an ion inverter for use in an electromagnet for a synchrotron. Circuit diagrams are presented, and equations are given for the power consumption for each method. In the first, the inverter is triggered directly from a three-phase network. This scheme is the simplest, but is limited to cases where the frequency of the resonance circuit is close to that of the network. In the second, the resonance circuit is excited directly from the inverter by a discontinuous current. This scheme requires less power but may not be applicable for ferrous core magnets, since the allowable frequencies may be less than needed to flatten the pulsating current in the working regime of the inverter. In the third, the inverter is triggered by a starting capacitor. The circuit for this method is more complicated, but it can be used over a wide range of frequencies. Here the circuit differs from the usual starting-capacitor circuit in that an inductance is used instead of a resistance to prevent recharging of the capacitor. (TTT)

37425 USE OF AN INVERSION TRANSFORMER TO FEED A SYNCHROTRON MAGNET. Belyak, A. Ya.; Gromov, A. M.; Gusev, O. A.; Nechaev, A. G.; Tsvetkov, V. G. p.145-51 of "Elektrofizicheskaya Apparatura. Vypusk 3." Moscow, Atomizdat, 1965. (In Russian)

Operations are described of a parallel ion inversion transformer with artificial commutation, as used to power the magnets of a 280-Mev synchrotron. The use of artificial commutation increased the stability of the magnetic field by a factor of 6. The magnitude of the magnetic field was maintained stable to 0.3%. The system was used to maintain a stable square-wave output of 170-Mev electrons for runs of up to 30 min. (TTT)

37426 METHOD OF OVERCOMING THE MULTIPACTOR EFFECT IN A CYCLOTRON ACCELERATOR SYSTEM. Kannowade, Heinz; Schwarzer, Dieter (to Licentia Patent-Verwaltungs-GmbH). German Patent 1,190,119. Apr. 1, 1965. Filed Dec. 13, 1963.

A resonant circuit tuned to the frequency of the accelerator system was coupled to the accelerator system in such a way that a shock excitation of the system was achieved. (Gmelin Inst.)

37427 HIGH VOLTAGE TERMINAL FOR TANDEM TYPE CHARGED-PARTICLE ACCELERATOR. Christofferson, James (to High Voltage Engineering Corp.). U. S. Patent 3,184,621. May 18, 1965. Filed Mar. 20, 1962.

A high-voltage terminal for a very large accelerator is designed to permit access to the interior without removal or displacement of the entire terminal. The terminal consists of a number of electrically interconnected tubular metallic members mounted in closely spaced parallel relationship on annular support members so as to form a cylindrical cage. The tubular metallic members are individually removable from the cage. (A.G.W.)

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Refer also to abstracts 37200, 37510, 37689, and 37730.

37428 (N64-32896) RESEARCH ON ELEMENTAL ABUNDANCES IN METEORITIC AND TERRESTRIAL MATTER. Summary Progress Report, September 1, 1963–August 31, 1964. Schmitt, R. A. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Contract NASw-843. 13p. (NASA-CR-59018; GA-6594). CFSTI, $1.00 cy, $0.50 mn.

Abundances of 14 rare-earth elements and of Y, Na, Sc, Cr, Mn, Fe, Co, and Cu were determined by the technique of instrumental neutron-activation analysis. Radioisotopes (2.56-hr to 5.3-yr half lives) of these elements were generated in meteoritic stony matter by thermal-neutron activation and were measured by gamma-ray scintillation spectrometry. Zirconium abundance was determined by emission spectrographic techniques. A computer program (IBM-7044) was devised for calculating abundances, using the peak area method. (CFSTI)

37429 (NASA-SP-7017) PLANETARY ATMOSPHERES. A Continuing Bibliography. (National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.). June 1965. 145p. CFSTI, $1.50 cy.

A selection of annotated references is given to unclassified reports and journal articles on studies, measurements, and discussions concerning the atmospheres of Mars, Venus, and Jupiter and, to a limited extent, of Mercury and Saturn. References are also included to specific topics such as the theory of planetary origins, extraterrestrial environment, planetary exploration and spacecraft reentry, and the physical properties of the planets and to the techniques of planetary observation and measurement. Citations and abstracts are given for each entry. All articles cited were introduced into the NASA Information System during Jan. 1962 to Feb. 1965. Subject and personal author indexes are included. (M.J.T.)

37430 (UCRL-14242) HYDRODYNAMIC CALCULATIONS OF GENERAL RELATIVISTIC COLLAPSE. May, Michael M.; White, Richard H. (Lawrence Radiation Lab., Univ. of California, Livermore). June 7, 1965. Contract W-7405-eng-48. 40p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The general relativistic equations governing the motion of a large mass under the influence of its own gravitational field and its own pressure are approximated by finite difference equations. A spherically symmetric, co-moving frame of reference is used. The pressure is assumed to be zero at the outer boundary. Rest mass is assumed to be conserved, and heat transfer by neutrinos, radiation, etc., is not taken into account. Numerical solutions were obtained on a computer for several simplified equations of state, chosen to bracket the behavior of stellar material in late stages of collapse, and several masses. The maximum stable masses obtained are of the same order of magnitude as, but somewhat larger than, the maximum stable masses calculated statically. Estimates of the amount of mass which can be thrown off are made. The behavior of light signals, metric coefficients, and hydrodynamic quantities as functions of time is described for a case of collapse continued past the Schwarzchild radius. (auth)

37431 (FTD-TT-65-82) CERTAIN REMARKS ON THE ROLE OF RADIATION EFFECTS IN THE THEORY OF ASTRAL SHOCK WAVES. Klimishin, I. A. Translated from Vopr. Kosmogonii, Akad. Nauk SSSR, 9: 200-2(1963). 6p. CFSTI.

The influence of the effects of radiation on the parameters of the shock wave moving in the stellar atmosphere is briefly discussed. (auth)

37432 THE INTERPRETATION OF THE SUN'S XUV RADIATION. Allen, C. W. (Univ. of London Observatory, London). Ann. Astrophys., 28: 146-7(1965).

The earth's ionosphere and the solar atmosphere are considered in relation to the recent observations of solar XUV (x and uv) radiation. The expected ionospheric characteristics are derived as directly as possible from the XUV observations and then compared with the well known E and F layer formation: agreement does not come naturally. There are indications of a high ionospheric recombination coefficient decreasing rapidly with height. It was found that radiations from the high ions have greater solar cycle variations than radiations from the low ions. This leads to difficulty in explaining the constancy of the E to F1 critical frequency ratios. Both uv and x rays appear to contribute to the E layer. There are about 250 identified XUV solar emission lines from about 50 ions. The flux measurements for each line gives information on the number of corresponding ions in the solar atmosphere. Each radiation comes from a region with a well-specified temperature selected from the whole available range 20,000 to 2,000,000°K. This makes it possible to derive: the amount of solar material in each temperature range; the chemical abundances; and the physical differences between normal solar atmosphere, centers of activity, and flares. The analysis is held up at present until the problem of the dielectronic recombination coefficient is cleared. A good distribution of matter with temperature should be available eventually but the fitting of such results to chromospheric and coronal models provides many problems. Several discussants provided supplementary remarks and data. (BBB)

37433 A SPECTROSCOPIC STUDY OF QUIESCENT PROMINENCES. Tandberg-Hanssen, Einar (High Altitude Observatory, Boulder, Colo.). Astrophys. Norvegica, 9: 13-32(1964).

Spectra of quiescent prominences were analyzed, and tables of prominence line intensities are given. The differences between spectra of quiescent prominences, flares, and active prominences are discussed. The analysis shows that the spectra of quiescent prominences are characterized by lines due to Sc II, Ti II, and Y II while flare conditions seem to be selectively conducive to lines of Fe II. The excitation conditions are discussed. (auth)

37434 INCLINED INHOMOGENEITIES IN THE SOLAR PHOTOSPHERE. Evans, John W. (Air Force Cambridge Research Labs., Sunspot, N. Mex.). Astrophys. Norvegica, 9: 33-54(1964).

The threads of the solar spectrum are the bright and dark streaks parallel to dispersion due to bright and dark inhomogeneities ~1000 km wide in the solar atmosphere. They are prominent in the continuum and are traceable with varying contrast through some or all of the Fraunhofer lines. In the wings of very strong lines, many of the bright threads are curved, with $\bar{x}$-displacements (perpendicular to dispersion) up to 1000 km on the sun. At $\Delta\lambda = 0.2$A from the center of Fe 4383.6 the rms x-deviation of threads from their positions in the continuum is $\bar{x} = 500$ km. If it is assumed that the height observed in the photosphere is an inverse function of $\Delta\lambda$, the curved threads correspond to strongly inclined bright elements

in the solar atmosphere. If also a specific height, h, is observed at the center of a weaker line, the thread displacements in this line should be the same as at the corresponding $\Delta\lambda_h$ in Fe 4383.6. A comparison of the x coordinates of 6 threads in 15 weaker lines shows that for each of the lines this expectation is fulfilled. There is a difficulty with the inclined element explanation, however. The x-deviations of threads are large at $\Delta\lambda$'s greater than 5 Doppler widths in Fe 4383.6, $\Delta\lambda$'s at which the height observed might be expected to be indistinguishable from the level of continuous absorption. One alternative explanation is suggested but does not appear promising. (auth)

37435 THE PROBLEM OF THE PLASMA FLUX AND THE MAGNETIC FIELDS IN INTERPLANETARY SPACE. Biermann, L.; Luest, R. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Astrophys. Norvegica, 9: 61-6 (1964).

The problem of the plasma flux and the magnetic field in interplanetary space is discussed taking into account the new data obtained from the space probe Mariner II. It is pointed out that the conclusions from the directions of the cometary plasma are in agreement with the measurements. The direct observations of magnetic field strengthened the hypothesis that the interaction of the solar wind with the cometary tail plasma is strongly affected by magnetic fields carried by the solar wind. It is proposed that the observed interplanetary magnetic fields are largely flux loops carried away from the sun by the solar wind. This picture is related to one developed by Babcock to explain the origin of the solar magnetic fields in the polar region. The difficulty of the severing of the field lines from the surface and their reconnection is discussed. Even the most reasonable upper limit of the effective resistivity is so low that the separation must very probably take place under conditions differing widely from equilibrium conditions. In this way this problem might be connected to the acceleration of cosmic ray particles. Finally some rough estimates are given for the magnetic flux carried away from the sun and the magnetic field strength expected in the interplanetary space according to this picture. The theoretically obtained values are not unreasonable as compared to the magnetic flux of sunspots. It shows furthermore that the picture of a continuous transport of magnetic fields from other stars might be also of importance for the interstellar magnetic fields. (auth)

37436 ON THERMAL CONDUCTIVITY IN DEGENERATE STELLAR CORES. Wyller, Arne A. (California Inst. of Tech., Pasadena and Carnegie Institution of Washington, D. C.). Astrophys. Norvegica, 9: 79-88(1964).

The hypothesis that internal magnetic fields affect the stellar-core thermal conductivity anisotropically, producing instabilities in the stellar structure, is explored formally. The previously obtained formulations of thermal conductivity tensors for a nonrelativistic nondegenerate gas are used in the derivation of the corresponding quantities for a nonrelativistic degenerate gas. Expressions for the thermal conductivity in a Lorentz-type hydrogen gas, where one component is much heavier than the other component, are obtained for cases of the absence and the presence of a magnetic field. (M.J.T.)

37437 ON THE LIFETIME OF SUNSPOT GROUPS. Ringnes, Truls S. (Universitet, Oslo). Astrophys. Norvegica, 9: 95-101(1964).

A study is made of the age-frequency distribution of sunspot groups. The analysis covers the interval 1888-1955. The results are critically compared with quantitative deductions made previously on the basis of a paper by Gnevishev. (auth)

37438 OSCILLATIONS IN A NON-ADIABATIC ATMOSPHERE SURROUNDED BY A HOT CORONA. Simon, R. (Universite, Liege). Astrophys. Norvegica, 9: 113-22 (1964).

Linear and radial oscillations of a nonadiabatic atmospheric layer are investigated under an extreme nonadiabatic assumption. These oscillations are excited by a given displacement δR_0 and by a given flux variation δF_0 at the bottom R_0 of the layer. Moreover, the atmospheric layer is surrounded by an infinite tenuous and hot corona in which progressive waves can freely escape. These waves provide a dissipative mechanism associated with resonance situations—i.e., maxima of the ratio between the amplitudes of the oscillation at the top and at the bottom of the nonadiabatic layer, respectively—occurring for particular values of the pulsation frequency. In these resonance situations the luminosity curve coincides with the velocity curve at the star's surface (top of the atmospheric layer) as in actual Cepheids and RR Lyrae stars, provided there is a phase opposition between the displacement and the flux variation at the bottom of the layer and provided a certain quantity β—roughly equal to the amplitude of $\delta F_0/F_0$ divided by the amplitude of $\delta R_0/R_0$—is larger than unity. It is also noticed that even in the absence of such a phase opposition, i.e., if the maximum luminosity at R_0 does not coincide with the maximum compression of the sphere R_0, and even if the pulsation frequency is different from a resonance value, the atmospheric oscillation may have nevertheless an appreciable nonstationary character. (auth)

37439 SOME GENERAL COMMENTS ON THE PROBLEM OF STELLAR STABILITY. Ledoux, P. (Universite, Liege). Astrophys. Norvegica, 9: 187-97(1964).

Some remarks are formulated concerning the influence of nuclear equilibrium on dynamical stability and the implications, for the general stellar stability problem, of neutrino emission by mechanisms related to the direct electron-neutrino interaction. In particular, it is shown that models in which thermonuclear energy generation is balanced mainly by the emission of neutrinos, while secularly stable, would be vibrationally unstable. Finally, it is suggested that the complete differential system being of a higher order than the third, there might exist significant time scales distinct from the usual three associated with the discussion of stellar stability. (auth)

37440 CALCULATIONS OF MAIN-SEQUENCE STELLAR MODELS. Reiz, Anders; Petersen, Joergen Otzen (Copenhagen Observatory). Astrophys. Norvegica, 9: 213-23(1964).

A computer technique for the calculation of stellar models was used for deriving evolutionary tracks of massive stars on the main sequence. The solution of the overall problem of stellar structure is achieved by numerical integration of the four classical differential equations expressing the conditions of mechanical and thermal equilibrium in a quasistationary state. Opacity values for specific chemical compositions given as functions of temperature and density were used. The formula used for rate of energy generation due to proton-proton and CNO cycles and to gravitational energy release is presented. The fitting procedure for the inward- and outward-running integrations is described. Results are given for population I stars of 6, 10, and 15 solar masses and age-zero composition X = 0.70, Y = 0.27, and Z = 0.03. (M.J.T.)

37441 AN ASSESSMENT OF THE PRESENT STATE OF THE GRAVITATIONAL N-BODY PROBLEM. Aarseth, S. J.; Hoyle, F. (Cambridge Univ., Eng.). Astrophys. Norvegica, 9: 313-21(1964).

Work carried out so far on the use of computer calculations in following the development of a galactic cluster for different initial conditions, to decide how far the observed properties are due to initial conditions and how far due to subsequent dynamical evolution, is described. Means of increasing the speed of calculation are considered. For the stellar case, galactic computation methods are sufficient for dealing with some thousands of stellar members; when the fluctuating force field due to nearest neighbors plays an important role, it is hoped that the main features will be revealed by about 300 members. For a very large number of members, the force-field of distant members is predominant, and the local fluctuating field may be neglected, treating the assembly as collisionless. (M.J.T.)

37442 THE ENERGY DENSITY OF SOLAR WIND AND ITS CORRELATION WITH COSMIC RAY INTENSITY. Sas-

try, CH. V. (Yale Univ., New Haven). Indian J. Phys., 39: 51-2(Jan. 1965).

A power spectrum analysis is made on the daily mean energy density and the daily mean cosmic ray intensity. If the present results are confirmed, conclusions can be drawn regarding interplanetary gas dynamics and solar modulation of galactic cosmic rays. (J.F.P.)

37443 2800 MEGACYCLE PER SECOND RADIATION ASSOCIATED WITH TYPE II AND TYPE IV SOLAR RADIO BURSTS AND THE RELATION WITH OTHER PHENOMENA. Harvey, Gladys A. (National Research Council, Ottawa). J. Geophys. Res., 70: 2961-76(July 1, 1965).

Emission at 2800 Mc/s (λ = 10.7 cm) was examined for 164 solar-flare events in 1957-1961 that displayed type-II and/or type-IV emission at meter wavelengths. Characteristics of the centimeter bursts are presented and discussed in relation to the meter bursts, flares, the magnetic class of the associated sunspots, ionospheric disturbances (SWF), and geomagnetic and solar proton (PCA) effects. No centimeter bursts were detected for 13% of the events; bursts with an impulsive profile were observed for 82% of the events. Of the impulsive bursts, 74% reached maximum quickly, displaying a simple, narrow burst profile (average half-width 1.8 minutes); the rest had complex profiles containing a predominant broad component (average half-width 17 minutes). The narrow profile bursts are considered to be M type, and the broad profile bursts to evidence type-IVμ emission. The majority of the narrow profile centimeter bursts corresponded to events in which only a type-II burst was observed at the meter wavelengths. When type-IV bursts were observed at the meter wavelengths, narrow profile centimeter bursts were seen in 43% of the cases and broad profile bursts in 57%. A strong association with magnetically complex sunspots, flares of importance $\geq 2^+$, SWF of importance $\geq 3^-$, geomagnetic storms, and PCA was found for only those events in which the centimeter burst had a broad profile. It is concluded that the peak intensity and the half-width of the burst profile at 2800 Mc/s enable solar events with a significant association with geomagnetic and PCA activity to be recognized. (auth)

37444 LONG-TERM (SOLAR CYCLE) VARIATION OF THE EXTREME ULTRAVIOLET RADIATION AND 10.7-CENTIMETER FLUX FROM THE SUN. Anderson, Albert D. (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Geophys. Res., 70: 3231-4(July 1, 1965).

It is shown that the 10.7-cm flux from the sun does not vary the same as the extreme ultraviolet radiation, especially over a solar cycle. (D.C.W.)

37445 NOTE ON THE CHARACTERISTICS OF TYPE IV SOLAR RADIO EMISSION. Sakurai, K. (Kyoto Univ.). J. Geophys. Res., 70: 3235-7(July 1, 1965).

The time relations among the three components of type-IV emission are studied, and the estimation of the cutoff frequency is considered. A magnetic field structure for sunspots above flare regions is proposed in terms of which the observations can be interpreted. (D.C.W.)

37446 THE BARIUM STARS. Warner, Brian (Univ. of London Observatory). Monthly Notices Roy. Astron. Soc., 129: 263-97(1965).

Cassegrain spectra of all known barium stars and coudé spectra of 12 barium stars are discussed. The low dispersion plates are used to set up a system of classification, giving a temperature class and a heavy-metal abundance criterion. The coudé plates are used to give elemental abundances in nine of the stars. Overabundances of the heavy elements are satisfactorily explained by the s-process of nucleosynthesis, with the possible exception of an anomaly in the Pr abundance. In all stars the required number of neutrons per original Fe nucleus in order to build most of the heavy metal abundances is found to be ~40. The fraction of Fe exposed to neutron irradiation varies from 0.5×10^{-3} in the most extreme. Overabundances of carbon by factors of 3 to 5 are indicated. Coupled with an apparent slight overabundance of Na this suggests that the peculiar abundances have arisen from the effects of carbon-burning in the interior of the stars. It is shown that the most consistent picture arises from considering mixing to have started when only 1 per cent of the C in the active region had been consumed. This active region may be identified with a carbon-burning shell near the surface of the core in late stages of evolution. The observed metal-to-hydrogen ratio, larger than normal, in the Ba star atmospheres is probably due to mixing of a helium shell with the hydrogen envelope. Absolute magnitudes of 3 Ba stars and 2 MS stars, derived by means of the H and K emission width method, are reasonably consistent with the hypothesis of C burning (or later nuclear energy sources) in the cores of the Ba stars. It is suggested that the Ba stars represent a normal stage of development in Population I stars of masses 1-4 $M_\odot$. The stars of 3-4 $M_\odot$ also pass through the S star stage. Carbon stars may represent a similar evolutionary stage of slightly more massive stars. Population II stars also evolve through at least the Ba star stage. (auth)

37447 NEUTRINO EMISSION IN THE LATE STAGES OF MASSIVE STAR EVOLUTION. Masani, A. (Osservatorio Astronomico di Brera, Milan); Gallino, R.; Silvestro, G. Nuovo Cimento (10), 38: 1142-68(Aug. 1, 1965).

The advanced evolutionary phase of massive stars [$M = (10^2$ to $10^4)M_\odot$] is studied by using Hoyle-Fowler models in order to define some problems which could have importance in a theory of Supernovae (type II). For such a purpose, and since the time evolution of the collapse is completely governed by neutrino emission, a brief analysis of all the neutrino production processes is presented. The role played by electron-positron creation on the photo-neutrino process is considered. For nondegenerate electrons, there results a much more efficient process than that first calculated by Chiu and by Ritus, but the energy loss per gram per second is only $\sim 10^{-3}$ times the one from the pair annihilation process. The peculiar importance of the new URCA process recently proposed by Pinaev and by Wataghin is also considered. This process, which is well established and is independent of the Feynman theory on weak interactions, is extremely efficient; and even, in some physical conditions, it predominates over all the other Feynman processes, maintaining the astrophysical validity of the conclusions, even if the Feynman theory should be invalidated in the future. Time scale and total energy loss by neutrino emission during collapse are calculated. Mechanisms which could prevent the collapsing star to reach the Schwarzschild singularity are discussed, namely, carbon thermonuclear reactions, rotation, and magnetic pressure. (auth)

37448 NEUTRINO EMISSION BY THE URCA PROCESS IN NEUTRON STARS. Ellis, David G. (Indiana Univ., Bloomington). Phys. Rev., 139: B754-6(Aug. 9, 1965).

The neutrino emission rate due to the reaction $n + n \rightarrow n + p + e^- + \bar{\nu}$, occurring in the interior of a neutron star, is calculated numerically. A highly degenerate Fermi-Dirac distribution is assumed for the neutrons and electrons; collective effects are ignored. The calculation is done relativistically, and for several values of the temperature and density. The results are in rough agreement with the estimates of other authors. (auth)

37449 THE MAGNETIC FIELD OF THE GALAXY. Berge, Glenn L.; Seielstad, George A. Sci. Am., 212: 46-54(June 1965).

The magnetic field of the galaxy is investigated. Radio astronomy is a successful method since radio waves are unaffected by dust particles in space. Observation of the Zeeman effect on radio waves gives the strength of the field and its orientation in space. The polarization of star light and the strength of a field required to maintain the position of the spiral arms of the galaxy are other means of determining the field strength. Faraday rotation is another means used to determine the field. It is concluded from experiments that there is a magnetic field perpendicular to the great circle passing through the galactic poles. Further details are investigated, and a model is worked out. (J.F.P.)

37450 PRIMORDIAL RARE GASES IN METEORITES. Pepin, Robert O.; Signer, Peter (Univ. of Minnesota, Minneapolis). Science, 149: 253-65(July 16, 1965).

Studies of rare gases in meteorites are reviewed. All meteoritic rare gases that are of neither radiogenic nor cosmogenic origin are called primordial rare gases. Concentrations of primordial He, Ne, Xe, Kr, and Ar in various meteorites are listed. Data indicate a mixture of two independent kinds of light rare gases. One of these two types (residue from primeval gases) is predominant in the gas-rich meteorites, the other addition from solar wind in the carbonaceous and enstatite chondrites. Except for xenon and helium, the relative elemental and isotopic abundances of all primordial rare gases in these meteorites are very similar to abundances in the earth. (62 references). (M.C.G.)

37451 ON THE QUESTION OF THE INFLUENCING OF RADIATION TRANSPORT BY COLLECTIVE EFFECTS. Kegel, Wilhelm H. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Astrophys., 61: 232-6(1965). (In German)

The cross section for light scattering by free electrons is reduced by collective effects in a plasma. The question is whether this effect can be essential for the radiative transfer in stars. It is shown that the change of the mean absorption coefficient $\bar{\varkappa}$ due to collective effects is less than 2% for an element mixture corresponding to population I stars and less than 8% for an element mixture corresponding to the extreme population II. (auth)

37452 NEUTRINO FLUX LIMITS AND AN EXPERIMENTAL TEST OF BARYON CONSERVATION. Kropp, William R. Jr. Thesis, Cleveland, Case Inst. of Tech., 1964. 71p.

An experiment was performed in which events not directly attributable to cosmic rays or natural radioactivity were observed in a 200-liter liquid scintillation detector. Shielding from cosmic rays was obtained through anticoincidence techniques and by locating the detector 585 m underground. Background from natural radioactivity was reduced by placing high energy requirements on acceptable events. The residual signal was used to establish lower limits on the stability of nucleons and an upper limit on the product of the cross section for the elastic scattering of neutrinos by electrons and the neutrino flux from the decay of ^{8}B and ^{7}Li in the solar interior. Depending on the assigned decay modes, nucleon lifetimes in the range 0.5 to 4×10^{23} years were obtained. The upper limit on the elastic scattering cross section, neutrino flux product was found to be ~20 times the theoretically predicted value. (Dissertation Abstr.)

Atomic Physics

Refer also to abstracts 36347 and 36438.

37453 (BNL-9244) DISTRIBUTION OF MAGNETIC MOMENT DENSITY IN Tb. Steinsvoll, O.; Shirane, G.; Nathans, R. (Brookhaven National Lab., Upton, N. Y.); Alperin, H. A.; Pickart, S. J. (Naval Ordnance Lab., White Oak, Md. and Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 11p. (CONF-650804-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 5th Rare Earth Research Conference, Ames, Iowa.

The magnetic form factor of metallic terbium was measured at 4.2°K by scattering of polarized neutrons with wavelength $\lambda = 0.8$Å from single crystal samples. Using a split coil superconducting magnet giving a field of 40K Oe across the crystal, it was possible to magnetize the samples close to saturation along both the a- and the b-directions, the latter being the direction of easy magnetization. The over-all agreement with theoretical calculations for the Tb^{3+} ion form factor is satisfactory. The experimental points were found to lie on a smooth curve which is consistent with the theoretical prediction that the terbium magnetic moment density has a disc-shaped distribution normal to the resultant moment direction. (auth)

37454 (NP-15238) OTRITSATEL'NYE IONY ATOMOV (OBZOR). (Negative Ions of Atoms. (A Review)). Smirnov, B. M. (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 93p. (IAE-810). Dep. mn.

Methods for determining the binding energy of electrons in negative ions and their reliability are surveyed; energies of electron affinity to atoms are presented. The behavior of a weakly bound electron in a negative ion is considered, including the electron wave function, the negative-ion polarizability, ion disintegration in a constant electric field, and electron elastic scattering on atoms. Photodisintegration of negative ions and radiative electron capture by atoms are reviewed, with discussions of photodisintegration cross section and photodetachment of s- and p-electrons from negative ions. Descriptions are given of the destruction of negative ions in collisions with electrons, interactions of negative ions with atoms and with positive ions, and breakup of negative ions in collisions with atoms. The formation of negative ions in plasma is briefly reviewed. 201 references. (M.J.T.)

37455 (NYO-1480-20) ASYMPTOTIC WAVE FUNCTIONS FOR ATOMIC SYSTEMS. Mendelsohn, Lawrence; Percus, Jerome (Courant Inst. of Mathematical Sciences, New York Univ., N. Y.). Apr. 30, 1965. Contract AT-(30-1)-1480. 64p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A new technique for calculating wave functions for atoms and ions is developed. Formal asymptotic expansions with largeness parameter Z (nuclear charge) are determined through first order in 1/Z. In so doing the Schroedinger equation for a general atomic system with N electrons is reduced to a set of first order partial differential equations which are solved recursively. Screening and correlation are exhibited explicitly in the resulting asymptotic atomic wave functions. Applications made to the ground state of 2 electron systems show that the asymptotic wave function obeys the virial theorem through first order. Magnetic susceptibilities within 5% of the accepted values are obtained for helium and singly ionized lithium. Other expectation values, $\frac{1}{2}(s_1 + s_2)$, s_{12}^2 and s_{12} are found to be in excellent agreement with a variational calculation utilizing 1078 parameters. In determining the asymptotic wave function in regions about certain singular points by a "matching technique", $\ln Z/Z$ terms enter. The omission of such terms in ordinary variational-perturbation wave functions may result in a loss of accuracy when computing expectation values other than the energy. (auth)

37456 (ORNL-3778(p.9-12)) MULTIPLE IONIZATION IN ATOMS AND ITS RELATIONSHIP WITH ELECTRON CORRELATION. Carlson, T. A.; Krause, M. O. (Oak Ridge National Lab., Tenn.).

Measurements have been made of the relative abundance of ions resulting from photo-ionization in the outer shells of He, Ne, and Ar and from the L-MM Auger process in Ar. It has been suggested that most of the excess ionization observed is related to the phenomenon of electron correlation. (auth)

37457 (ORNL-3778(p.123-5)) SOME HEAVY-ION STOPPING POWERS. Moak, C. D.; Brown, M. D. (Oak Ridge National Lab., Tenn.).

Multicomponent beams of Br and I ions from the Tandem Van de Graaff Accelerator have been used to measure the stopping powers of several elements in the energy range of 10 to 100 Mev. (auth)

37458 (ORNL-3778(p.150-1)) WAVE FUNCTIONS FOR MUON CAPTURE IN HYDROGEN μ-MOLECULAR IONS. Becker, R. L.; Patterson, M. R. (Oak Ridge National Lab., Tenn.).

Binding energies, muon-proton overlap, and mean internuclear separation are given in the adiabatic approximation for the ground and first excited states of the $p\mu p$ and $d\mu d$ molecules. (auth)

37459 (PUC-1964-148) FREQUENCY SHIFTS IN ATOMIC BEAMS RESONANCES (thesis). Happer, William Jr. (Princeton Univ., N. J. Palmer Physical Lab.). July 1964. Contract AT(30-1)-937. 123p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Experimental and theoretical investigations of the resonance frequency shifts arising in atomic beams machines were carried out. Special attention was devoted to the effects arising from small inhomogeneities in the C field. The inhomogeneities were expressed in a power series along the path of the beam and the Schroedinger equation was integrated numerically for a realistically shaped r-f envelope to obtain resonance line shapes. Single quantum transitions and well separated multiple quantum transitions were studied. Experimental and theoretical results are in good quantitative agreement. A linear C field inhomogeneity causes no frequency shift but broadens the resonance line and increases the r-f power required for optimum transition probability. Quadratic inhomogeneities small enough to have negligible effects on the resonance line width can cause large frequency shifts. The frequency shifts show regular oscillations with increasing r-f power. In multiple quantum transitions the frequency shifts caused by the r-f field can be as large as the shifts due to C field inhomogeneities. Prevision measurements of r-f magnetic fields were accomplished by using a small secondary r-f field of frequency ν_2 to induce transitions between the stationary states defined by the main r-f field at the frequency ν_1. Resonances may be observed at the frequencies $\nu_2 = \nu_1 - \nu_1'$ and $\nu_2 = \nu_1'$ depending on the relative orientation of the r-f loops. Here ν_1' is the splitting between a pair of stationary states in the rotating coordinate system. The r-f field seen by the atom may thus be measured directly in gauss with an uncertainty determined by the linewidth of the resonance. (auth)

37460 (UCRL-7813) COPPER L_{III} SHELL X-RAY PRODUCTION BY 25-100 kev PROTONS. Potter, D. L.; Khan, J. M.; Worley, R. D. (Lawrence Radiation Lab., Univ. of California, Livermore). June 16, 1964. Contract W-7405-eng-48. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Recent x-ray production studies of L-shell x rays from copper by proton bombardment (100-500 kev) were extended to 25-kev energy. In the region of the periodic table near copper the higher intensity (L_{β_1}, $L_{\beta_{3,4}}$) characteristic x-ray lines from the L_I and L_{II} shells are absorbed in the L_{III} shell. By using thin copper absorber foils the characteristic x rays from the L_{III} shell of copper were isolated from the L_I and L_{II} characteristic x rays. The thick target yields of both groups are presented as well as the x-ray production cross section for the L_{III} shell. With a fluorescence yield of 0.05 the L_{III} shell ionization cross section decreases from 3.6×10^{-22} cm^2 at 100 kev to 2.3×10^{-24} cm^2 at 25 kev. The $L_{III}/L_I + L_{II}$ x-ray intensity ratio decreases from 1.4 at 100 kev to an extrapolated value of approximately 1 at zero proton energy. (auth)

37461 THE KEPLER PROBLEM IN TWO-DIMENSIONAL MOMENTUM SPACE. Shibuya, Tai-ichi; Wulfman, Carl E. (Univ. of the Pacific, Stockton, Calif.). Am. J. Phys., 33: 570-4(July 1965).

Fock studied the hydrogen atom problem in momentum space by projecting the space into a 4-dimensional hyperspherical space. He found that as a consequence of the symmetry of the problem in this space the eigenfunctions are the R_4 spherical harmonics and that the eigenvalues are determined only by the principal quantum number n. It is noted that if his method is applied to the 2-dimensional Kepler problem in momentum space, the eigenfunctions are R_3 spherical harmonics, Y_{lm}; and the eigenvalues are determined only by the quantum number l. These facts enable one to give a visualizable geometrical discussion of the dynamical degeneracy. (auth)

37462 THE NEGATIVE HYDROGEN ION IN QUANTUM MECHANICS AND ASTROPHYSICS. Hylleraas, Egil A. (Universitet, Oslo). Astrophys. Norvegica, 9: 345-9(1964).

A review is given of determinations of the electron affinity of the hydrogen atom and of the ground-state energy of the H^- ion, using quantum-mechanical methods. (M.J.T.)

37463 SECONDARY EMISSION FROM THIN METAL FOILS BOMBARDED WITH 70-Mev ELECTRONS. Blankenburg, S. A.; Cobb, J. K.; Muray, J. J. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 935-42(June 1965).

The secondary electron emission coefficient from several elements in the form of thin foils was measured using 70 Mev electrons as bombarding particles. Using foils with different atomic numbers, it was found that the secondary emission coefficient per target electron in the metal is noticeably larger for light elements, especially in cases of beryllium and aluminum. This indicates that metal oxide on the foil surface (Malter effect) is playing a dominant role in the secondary emission of these metals. For other metals, the experimental results seem to indicate a relatively small variation in the secondary emission coefficient per target electron. The lack of thickness dependence in the case of tantalum foils is in agreement with previous experimental work and theoretical treatment. The secondary electron emission coefficients are given for the measured foils and the experimental values are compared with the existing theories. Finally, the construction of a bakeable secondary emission current monitor is described. (auth)

37464 EFFECTS OF ELECTRON CORRELATION IN X-RAY AND ELECTRON DIFFRACTION. II. INFLUENCE OF NUCLEAR CHARGE IN TWO-ELECTRON SYSTEMS. Bartell, L. S.; Gavin, R. M. Jr. (Ames Lab., Ames, Iowa). J. Chem. Phys., 43: 856-61(Aug. 1, 1965). (IS-1076)

The electron-electron and electron-nuclear radial distribution functions $P(r_{12})$ and $D(r)$ were calculated for ground states of helium-like systems (Z = 2 to 8). Computations were based on the correlated and uncorrelated wavefunctions published by Roothaan et al. Elastic and inelastic scattering factors for calculating the intensities $I(\varphi)$ of x rays scattered by two-electron systems were determined from the distribution functions. The correction functions $\Delta P(r_{12})$ and $\Delta I(\varphi)$ representing the differences between correlated and uncorrelated results were found to follow a simple dependency on atomic number. It was observed that universal functions could be established, which closely approximated each of the functions $D(r)/Z^*$, $P(r_{12})/Z^*$, $I(\varphi)$, $\Delta P(r_{12})$, and $Z^*\Delta I(\varphi)$ for all of the systems studied if the functions were expressed in terms of the reduced variables $r' = Z^*r$ and $\varphi' = 2 \arcsin[Z^{*-1} \sin(\varphi/2)]$. The appropriate Z^* was very nearly the Slater effective nuclear charge. The experimental determination of $P(r_{ij})$ from x-ray scattering and the magnitude of correlation effects to be expected were briefly discussed. (auth)

37465 MEASUREMENT OF INELASTIC ENERGY LOSS IN SOME NOBLE-GAS ION-ATOM COLLISIONS AT KILO-ELECTRON-VOLT ENERGIES. Flinchbaugh, David E. (Univ. of Connecticut, Storrs). J. Chem. Phys., 43: 910-14 (Aug. 1, 1965).

Large-angle collisions of Ne^+ ions with Ar and Ne atoms, and protons with argon, were investigated, and the inelastic energy loss Q was measured as a function of incident energy, scattering angles, and state of ionization following the collision. Measurements for the Ne^+-on-Ar case were made at 3, 6, 12, and 25 kev incident energies, and both the recoil target particles and the scattered incident particles were studied at several angles between 15 and 85° with respect to the incident beam. The Ne^+-on-Ne and H^+-on-Ar data were taken at 25 kev over the same angular range. The kinetic energies and scattering angles were accurately measured, and this, together with the energy and momentum conservation equations, allowed determination of the inelastic energy. The average value of the inelastic loss $\overline{Q}$ was plotted vs recoil angle ϕ or vs scattering angle θ and a separate curve was obtained for each incident energy. However, when the various $\overline{Q}$ values were plotted vs the calculated distance of closest approach r_0, a universal curve was obtained for each ion-atom combination. The data points in each of the three cases studied appeared to fit best a curve giving $\overline{Q}$ as a function of r_0 to an inverse power. The protons especially showed deep penetration into the argon electron shell structure. Values of $\overline{Q}_n$, where n denotes the charge state of the collision product detected, were determined for each of several angles at each energy studied. (auth)

37466 EXCITATION OF MOLECULAR NITROGEN BY ELECTRON IMPACT. Winters, Harold F. (IBM Research Lab., San Jose, Calif.). J. Chem. Phys., 43: 926-32(Aug. 1, 1965).

Relative cross sections for excitation of the triplet series of molecular nitrogen were obtained. The cross sections had a maximum within a few volts of threshold as expected for electron exchange collisions. In particular, the $C^3\Pi_u$ state had a sharp maximum within a few tenths of a volt of threshold and then decayed sharply. The $A\ ^3\Sigma_u^+$ state had an increasing slope through the Franck–Condon region and then was a strictly linear function of energy for about 1½ v. It subsequently reached a maximum and started to decay. This led to the postulate that the region of increasing slope was caused by the continual excitation of new vibrational levels and that the excitation function of a given vibrational level may be linear to near threshold. This interpretation was shown to be consistent with the experimental data. (auth)

37467 VARIATIONAL APPROACH TO PERTURBATION THEORY. I. APPLICATION TO THE CALCULATION OF ATOMIC POLARIZABILITIES. Kolker, H. J.; Michels, H. H. (United Aircraft Corp., East Hartford, Conn.). J. Chem. Phys., 43: 1027-35(Aug. 1, 1965).

A variational approach to perturbation theory was derived, which established the relationship between variational and conventional approaches that utilize expansions in terms of atomic or molecular eigenfunctions. This approach was based on the observation that the variational approach to perturbation theory was formally equivalent to a variational method for constructing a special set of excited-state wavefunctions. A mathematical demonstration of this equivalence was formulated. With the use of this new approach to perturbation theory, both the static and dynamic polarizabilities of the two-electron helium isoelectronic series, H^-, He, and Li and a four-electron system represented by the beryllium atom were calculated. Multiconfiguration open-shell wavefunctions were employed. These flexible wavefunctions permitted a quantitative analysis of the near-degenerate s-p orbital mixing in the ground state of the beryllium atom. The inclusion of this orbital degeneracy effect resulted in a substantial reduction in the calculated polarizability. (auth)

37468 ON THE COLLISION MECHANISM OF BIMOLECULAR REACTIONS. IV. INTRAMOLECULAR ISOTOPE AND STRIPPING EFFECTS IN THE REACTIONS OF Ar^+ AND OF N_2^+ IONS WITH HD. Henglein, A.; Lacmann, K.; Knoll, B. (Hahn-Meitner-Institut fur Kernforschung, Berlin). J. Chem. Phys., 43: 1048-9(Aug. 1, 1965).

The velocity spectra and cross sections for the reactions of Ar^+ and of N_2^+ with HD were measured at different kinetic energies of the incident ions. The bands of the secondary ions ArH^+, ArD^+, N_2H^+, and N_2D^+ appeared at the positions in the velocity spectra predicted by the stripping model. The cross sections for H and D atom transfer were half as large as for the corresponding reactions with H_2 and D_2, respectively. The intensity ratio XH^+/XD^+ strongly increases at high energies as was expected from the stripping model. (auth)

37469 ELECTRON SPIN RESONANCE OF 15-N ATOMS. Ultee, Casper J. (United Aircraft Corp., East Hartford, Conn.). J. Chem. Phys., 43: 1080-1(Aug. 1, 1965).

Electron spin resonance spectra were observed for nitrogen dissociated in a 2450-Mc discharge. The observed splittings for ^{14}N and ^{15}N were 15, 90 and 22.24 kc/sec (proton resonance frequency), respectively, giving a ratio of 1.398, in agreement with the calculated value. The intensity ratio expected from the natural abundance of ^{15}N was 0.006 for single lines. Due to the weak ^{15}N signal and the narrow lines (~0.08 G), no accurate linewidth values could be obtained. The observed ratio of the signal amplitudes was approximately 0.009. An intensity ratio of $I(^{15}N)/I(^{14}N) = 0.009[\Delta H(^{15}N)/\Delta H(^{14}N)]^2$, where ΔH was the observed linewidth, was obtained. Differences in saturation behavior of the ^{14}N and ^{15}N could be responsible for slight departures from the expected intensity ratios since at the microwave powers used (~100 μW) saturation does occur. (J.F.H.)

37470 OSCILLATOR STRENGTHS OF LIGHT EMISSION EXCITED BY FAST ELECTRONS. I. MEASUREMENTS IN HELIUM. Boersch, H.; Reich, H. J. (Technische Universitaet, Berlin). Optik, 22: 289-306(Mar. 1965). (In German)

Oscillator strengths of transmissions from the ground level of the single He atom were determined from the emission of light (230 to 6000 Å) excited by the impact of 15-kev electrons. The rates of emission of photons gave total electron excitation cross sections which could be transformed into oscillator strengths by substituting the oscillator strength in Bethe's dipole approximation for the total cross section over the matrix element. The relative oscillator strengths of the He atom $f(1^1S-n^1P)$ (n = 2 to 7) confirmed the theoretical values. Experimental oscillator strengths of the simultaneous ionization and excitation of ionic levels with the same principal quantum number $f(n,k) = f(np,ks) + f(ns,kp)$ were determined for n = 2 to 7 and were numerically equal to the theoretical values f(ns,kp) known for n = 2 and 3. (TCO)

37471 WAVE FUNCTIONS FOR THE EXCITED STATES OF NEUTRAL HELIUM. Green, Louis C.; Kolchin, Eleanor K.; Johnson, Norma C. (Haverford Coll., Penna). Phys. Rev., 139: A373-8(July 19, 1965).

Wave functions were found for the excited states of neutral helium for the ^1S, ^3S, ^1P, ^3P, ^1D, and ^3D series up through terms for which the principal quantum number of the running electron is 9 for the S series and 8 for the others. The wave functions are obtained from the minimum principle by a configuration-interaction procedure. At the final stage of the calculation, the wave functions are found by the solution of a secular equation of order 9 × 9 or less. If one excludes the energy of the 1^1S term, the average agreement between computed and observed energies for the 42 remaining terms is better than 1 part in 300,000. The energies obtained for the more highly excited states appear to be more than an order of magnitude better than any which have been previously obtained. The values of the parameters in the various wave functions are made available. (auth)

37472 PSEUDOPOTENTIAL THEORY OF METALLIC LITHIUM. Meyer, Axel; Young, W. H. (Oak Ridge National Lab., Tenn.). Phys. Rev., 139: A401-9(July 19, 1965). (ORNL-P-943).

A detailed calculation of the electronic structure of a screened lithium ion is made, with a view to testing some of the assumptions and approximations which have been used in pseudopotential work. Within the confines of a linearly screened Austin pseudopotential it is concluded that for lithium, the Slater approximation in the treatment of core-valence exchange is qualitatively incorrect, the phase shifts considerably overestimate the screening charge, and the core states are little different from those of the free ion. It is emphasized that when calculating the form factor, it is better to use the Born approximation, which automatically scales by describing the forward scattering correctly, than to use approximate phase shifts which violate significantly the Friedel sum rule. (auth)

37473 DEFINITIVE DETERMINATION OF THE IONIZATION STAGE FOR SPECTRAL LINES. Malmberg, P. R. (Naval Research Lab., Washington, D. C.); Bashkin, S.; Tilford, S. G. Phys. Rev. Letters, 15: 98-100(July 19, 1965).

An experiment showing the stage of ionization appropriate to a spectral line by sending a foil-excited particle beam through a field which separates beam components of different net charge is described. This was done by passing a beam from a Van de Graaff accelerator through a thin carbon foil and observing the spectra of the separated beams. The spectral lines were then identified and tabulated with their corresponding charge stages. A direct definitive

measurement of the ionization charge stages for observed spectral lines is given. (J.F.P.)

37474 STRUCTURE AND OSCILLATOR STRENGTHS OF AUTOIONIZING LEVELS IN HELIUM. Altick, P. L.; Moore, E. Neal (Univ. of Nevada, Reno). Phys. Rev. Letters, 15: 100-2(July 19, 1965).

Eigenvalues and eigenvectors for several low-lying ^1P and ^3P autoionizing levels in helium are calculated. The structure of these states is explicitly obtained. Quantitative verification is given to the plus-minus classification scheme for the ^1P and ^3P states. Also oscillator strengths for the transitions from the ground state to the ^1P levels were computed. The method used was a configuration interaction with a basic set of hydrogenic orbitals having Z = 2. There were 10 configurations used. (J.F.P.)

37475 ANISOTROPIC ENERGY LOSSES IN A FACE-CENTERED-CUBIC CRYSTAL FOR HIGH-ENERGY ^{79}Br AND ^{127}I IONS. Datz, S.; Noggle, T. S.; Moak, C. D. (Oak Ridge National Lab., Tenn.). Phys. Rev. Letters, 15: 254-7(Aug. 9, 1965). (ORNL-P-1348).

Multicomponent beams of bromine and iodine ions from a tandem accelerator with energies up to 80 Mev were used to study crystal orientation effects on energy losses in thin gold single crystals. For these experiments gold single crystals were prepared by evaporation and epitaxial growth upon cleaved rock-salt faces. When the crystals were aligned in a certain direction it was observed that the energy losses were less than corresponding normal polycrystalline losses for a foil of this thickness. Although the peaks are asymmetric, the fraction of particles with normal energy loss was less than 0.1. Other crystal directions showed almost identical patterns. (J.F.P.)

37476 QUANTUM CORRECTIONS TO THE EQUATION OF STATE FOR A STEEP REPULSIVE POTENTIAL. Henderson, Douglas; Davison, Sydney G. (Univ. of Waterloo, Ontario). Proc. Natl. Acad. Sci. U. S., 54: 21-3(July 1965).

The equation of state of a system of molecules with a steep intermolecular potential was previously obtained from that of a system of hard spheres by an expansion in powers of n^{-1}, where n is a measure of the steepness of the potential (Rowlinson, J. S., Mol. Phys., 7: 349(1964); ibid., 8: 107(1964)). It is shown that for the repulsive intermolecular potential $u(r) = \epsilon(\sigma/r)^n$, this procedure can be extended to obtain quantum corrections to the equation of state. (C.E.S.)

37477 DIFFERENTIAL CROSS SECTIONS FOR ELECTRONS ELASTICALLY SCATTERED BY HELIUM ATOMS. Khare, S. P. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 86: 25-9(July 1965).

The differential cross sections for the elastic scattering of electrons by helium atoms at a few selected electron impact energies, in the 10 to 50 ev energy range, are calculated by using the adiabatic-exchange phase shifts of La-Bhan and Callaway for the l = 0, 1 and 2 partial waves and the static-dipole phase shifts for the higher partial waves. The calculated values are in satisfactory accord with the experimental data of Bullard and Massey and of Hughes and with the theoretical values of Khare and Moisciwitsch, who included exchange only indirectly. The effect of quadrupole polarizability potential on the differential cross sections is also examined and is found to be small. (auth)

37478 SCREENING DOUBLETS IN X-RAY EMISSION SPECTRA. Deodhar, G. B.; Varma, P. P.; Singh, R. B. (Allahabad Univ., India). Proc. Phys. Soc. (London), 86: 65-73(July 1965).

A detailed examination of the recent available data for dipole and non-dipole transitions in the K, L and M regions of spectra over the entire region of elements revealed the existence of a large number of new screening doublets. These, as well as those reported earlier by Sandström and by Deodhar and Padalia, were shown to fall under one of five categories based on the nature of the initial and final levels of the constituents of a doublet. The analysis revealed for the first time that in x-ray emission spectra there exist many screening doublets for which both the constituents are dipole lines. A mathematical interpretation for one of the screening doublets, $(L_IM_I, L_{II}M_{II})$, was given. (auth)

37479 INTERPRETATION OF THE SOFT X-RAY EMISSION SPECTRUM OF LITHIUM METAL. Goodings, D. A. (Univ. of Pittsburgh). Proc. Phys. Soc. (London), 86: 75-85(July 1965).

The shape of the soft x-ray emission spectrum of lithium was calculated in the Hartree-Fock approximation taking into account the fact than an atom about to emit a K x ray is a point defect in the otherwise periodic potential of the lattice. The perturbation from the 1s hole was treated in the "localized approximation" of the Koster-Slater theory, its effect being expressed by a single parameter. Starting from Ham's calculated density-of-states function and gradually increasing the strength of the perturbation, one observes the formation of a resonance state (virtual bound state) and then a real bound state. For reasonable values of the perturbation parameter the results show a peak about 1 ev below the Fermi energy, a feature which resembles the measurements of Crisp and Williams and others. The calculations also provide a plausible explanation of the measurements of Catterall and Trotter on the satellite K emission spectrum of lithium. (auth)

37480 THE LONG-RANGE INTERACTION BETWEEN HYDROGEN ATOMS. Bell, R. J. (National Physical Lab., Teddington, Middx., Eng.). Proc. Phys. Soc. (London), 86: 239-41(July 1965).

The long-range interaction energy between two normal hydrogen atoms was calculated directly, without recourse to laborious variational methods. The result confirms that of Chan and Dalgarno as opposed to that of Hirschfelder and Löwdin. (auth)

37481 ELECTRON IMPACT EXCITATION OF THE 2p STATE OF ATOMIC HYDROGEN. Bell, K. L. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 86: 246-8 (July 1965).

A discrepancy in the analysis of Corinaldesi and Trainor is pointed out, and it is shown that the correct procedure leads to a non-vanishing expression for the exchange scattering amplitude given by the Born-Oppenheimer approximation for excitation of the $m = \pm 1$ levels of the 2p state of atomic hydrogen by electron impact. This expression is used to correct earlier calculations of 1s-2p excitation total cross section. (auth)

37482 THE ISOTOPIC SHIFT OF THE HYPERFINE SPLITTING OF ATOMIC LEVELS. Troitskii, M. A. Yadern. Fiz., 1: 758-62(May 1965). (In Russian)

The isotopic shift of the hyperfine splitting is considered with the help of the finite Fermi-system theory. Equations are obtained for the quantities determining the isotopic shift. Results are compared with experimental data for ^{85}Rb, ^{87}Rb, ^{121}Sb, and ^{123}Sb. (auth)

37483 VIRTUAL LEVELS FOR A SCREENED COULOMB POTENTIAL. Trubnikov, B. A.; Yavlinskii, Yu. N. Zh. Eksperim. i Teor. Fiz., 48: 1618-19(June 1965). (In Russian)

The appearance of virtual levels in a screened Coulomb potential is considered. The magnitude of the critical Debye radius, d_K, for which the last bound state of a hydrogen-like atom in a screened Coulomb potential disappears, is determined. (auth)

37484 RADIATION FROM ATOMS IN AN ANISOTROPIC MEDIUM. Alekseev, A. I.; Nikitin, Yu. P. (Moscow Inst. of Engineering Physics). Zh. Eksperim. i Teor. Fiz., 48: 1669-78(June 1965). (In Russian)

The quantization of an electromagnetic field in an optically transparent nonmagnetic anisotropic medium is carried out. On this basis, the problem of radiation from an atom is solved. Dipole, magnetic-dipole, and quadrupole radiation are considered. The angular distribution of the radiation and also the total probability for emission per unit time of a quantum with a given polarization corresponding to the ordinary and extraordinary waves are de-

termined for the particular case of an uniaxial crystal. The polarization of the radiation from a quantum generator with an uniaxial ruby crystal is considered. (auth)

37485 HIGHLY EXCITED HYDROGEN ATOMS AND LORENTZ IONIZATION. Fedorenko, N. V.; Ankudinov, V. A.; Il'in, R. N. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 35: 585-604(Apr. 1965). (In Russian)

A review is presented on the ionization of excited atoms and the dissociation of molecular ions as a result of the Lorentz forces on the constituent electrons and nuclei due to motion in a magnetic field (Lorentz ionization) and on techniques for producing beams of highly excited hydrogen atoms. Methods for obtaining highly excited hydrogen atom beams are discussed, including dissociation of fast hydrogen molecule ions by collision with atoms or by the action of external fields, charge exchange collisions of protons with atoms or molecules, and the method of Luce involving the passage of a hydrogen molecule ion beam through an arc discharge. The radiation life time of excited hydrogen atoms is also discussed at some length. It is concluded that most desirable for injection purposes would be a beam of excited hydrogen atoms with the excitation spectrum sharply peaked in the range of principal quantum numbers between 6 and 15, and that the greatest hope of obtaining such a beam probably lies in the development of optical pumping methods. (ATD)

37486 MEASUREMENT OF THE ELECTRON COLLISION CROSS SECTIONS OF ATOMS AND MOLECULES OF CERTAIN GASES BY A DOUBLE-BEAM RADIOPROBE METHOD. Kozlov, G. I. (Power Engineering Inst., Moscow). Zh. Tekhn. Fiz., 35: 895-904(May 1965). (In Russian)

The collision cross sections of electrons with gas molecules were measured in the slightly ionized plasmas behind shock fronts by a radioprobe method. The plasma was produced in a previously described shock tube. The velocity of the shock wave was measured, and the temperature and pressure in the plasma behind the shock front were calculated from the initial values and the Mach number. The attenuations of 3.2 and 0.82 cm wavelength microwaves traversing the plasma were measured. The two microwave beams traversed the same region of space at right angles to each other and to the direction of motion of the shock wave. From the measured attenuations, the collision frequency was calculated (the theory of this calculation is reviewed), and the cross section was calculated from the collision frequency, the temperature, and the pressure. Measurements were made for Ar in the temperature range 2240-3030°K, for He in the range 3250-6090°K, and for N_2 in the range 2640-4400°K. In the case of the A measurements, small quantities of He or H_2 were added to provide adequate electron density. In no case was a variation of cross section with temperature perceptible. The measured cross sections in units of 10^{-16} cm^2 were: for Ar, 2; for He, 7.5; and for N_2, 4.8. These results are believed to be accurate to within ±20%. These results are compared with other data in the literature, and the reliability of the work of different authors is discussed. Measurements were attempted with CO_2, but measureable attenuations could not be obtained at temperatures at which CO_2 remained undissociated. Measured cross sections are given, but they relate to mixtures of dissociation products. (ATD)

37487 PRODUCTION OF NARROW BALMER SPECTRUM LINES IN AN ELECTRON-BOMBARDED ATOMIC HYDROGEN BEAM. Stoner, John Oliver J. Thesis, Princeton, N. J., Princeton Univ., 1964. 87p.

Methods applicable to the precise measurement of wavelengths in the atomic hydrogen spectrum are discussed, and a description of an apparatus successfully used for the production of narrow Balmer lines is presented. Atoms in a beam of atomic hydrogen were cross-bombarded by an electron beam. The optical radiation resulting from the decay of excited states produced by electron impact was observed in a direction perpendicular to the electron beam and hydrogen beam axes. The emission spectrum was passed through a Fabry-Perot interferometer and detected by a cooled photomultiplier. A 400-channel analyzer stored the output pulses from the photomultiplier as the interferometer was scanned. Although narrow H_β and H_γ lines were seen, precision wavelength measurements were not possible because of the weakness of the signals and uncertainties in the intensity distributions among the fine-structure components of the lines. (Dissertation Abstr.)

37488 THE 2S-3S EXCITATION OF HYDROGEN ATOMS BY ELECTRON IMPACT. Pomilla, Frank R. Thesis, New York, Fordham Univ., 1963. 122p.

The cross section for the 2s-3s excitation of hydrogen atoms by electron impact is calculated in the second Born approximation by including only terms to the third order in the interaction energy. Allowance is made for the spherical distortion and polarization of the target atom due to the 1s, 2s, $2p_{0,\pm1}$, 3s, $3p_{0,\pm1}$, $3d_{0,\pm1,\pm2}$ and 4s intermediate states. The results indicate that these states made a significant contribution to the cross section only for small-angle scattering, where the 3p state is the major contributor. At an incident energy of 220 ev (115 thresholds) there is still a 3% difference between the first Born and our third order approximations to the cross section, which is greater than previously expected. A comparison of our 2s-3s results with those of a similar calculation made on the 1s-2s excitation of atomic hydrogen suggests that the first Born approximation is a better approximation at the lower incident energies for electron scattering from excited states than for electron scattering from the ground state of hydrogen. (Dissertation Abstr.)

37489 LEVEL CROSSINGS AND ANTI-CROSSINGS IN THE 2P STATE OF LITHIUM. Wieder, Harold. Thesis, Cleveland, Case Inst. of Tech., 1964. 70p.

The change in resonance fluorescence that accompanies the crossing of two Zeeman levels of an atom in a magnetic field can be used to infer a value for the zero field splitting between these levels. Using this level crossing technique, the fine structure splitting in the 2P state of lithium is determined to be 10,053.0 ± 0.7 Mcps. Hyperfine structure in the observed crossings yields values for the magnetic dipole interaction constants in the 2P state of lithium and a value of $(-3.0 \pm 2.0) \times 10^{-26}$ cm^2 for the electric quadrupole moment of the Li^7 nucleus. The asymmetry found in one of the crossing signals was traced to a new type of interference phenomenon associated with off-diagonal coupling between hyperfine states. The origin and details of this "anti-crossing" signal are discussed. (Dissertation Abstr.)

Cosmic Radiation

See also Elementary Particles and Radiations. Nuclear Properties and Reactions.

Refer also to abstract 37442.

37490 (D-1-82-0417) NEUTRON FLUX MEASUREMENTS DURING JANUARY AND FEBRUARY 1964. Gauger, Joleroy (Boeing Scientific Research Labs., Seattle, Wash. Geo-Astrophysics Lab.). Mar. 1965. 96p.

Data relating to the secondary cosmic ray rates measured at aircraft altitudes over an extended geophysical area are presented in detail. Data gathered on two flights (20 January 1964 and 12 February 1964) yielded determinations of the position of the cosmic ray equator along the 40°N and 69°W longitude lines at ½° ± 1°N and 10° ± 2°S respectively. The experimental values compare favorably with the predictions of Shea and Smart. Extended range flights to 73°S latitude provided data pertinent to an evaluation of the position of the south latitude polar plateau. An anomalous neutron flux increase on 21 January 1964 accompanied by an increase in night air glow intensity (5577 Å) is related. The summed data over northern and southern hemispheres allow a comparison of several rigidity models. From the comparison it is apparent that the Makino treatment defines the latitude effects noted better than do the

models of Quenby-Webber, Quenby-Wenk, or a rigidity model based on the McIlwain L parameter. (auth)

37491 (N64-29364) COMPUTER CODES FOR THE EVALUATION OF SPACE RADIATION HAZARDS. VOLUME 2. VAN ALLEN RADIATION. Wong, Wing Y. (Boeing Co., Seattle, Wash. Aero-Space Div.). [nd]. Contract NAS9-1393. 72p. (NASA-CR-58293). CFSTI, $7.60 cy.

This program is an all-FORTRAN code, which computes the flux and the total time-integrated fluxes of protons and electrons for vehicle trajectories along the Van Allen radiation belt. For study purposes, this belt is differentiated into four separate belts: (1) high-energy proton belt, for protons with energy greater than 20 Mev; (2) low-energy proton belt, for protons with energy less than 20 Mev; (3) AFSWC threat electron belt, which is a theoretical belt; and (4) electron belt, as it existed on October 20, 1962. These belts are represented by spatial flux maps, which are read as inputs to the program. These maps were constructed from empirical measurements received from satellites. Flux values are given as functions of B (magnetic flux density in gauss) and of L(McIlwain parameter in units of earth radii). (CFSTI)

37492 THE COSMIC PHYSICS LABORATORY AT CHACALTAYA. Escobar, Ismael (Laboratorio de Fisica Cosmica, Chacaltaya, Bolivia). Ciencia Interam., 2: 3-8(Nov.-Dec. 1961). (In Spanish)

The laboratory at Chacaltaya is described, including the equipment and research program. (D.C.W.)

37493 27 DAY MODULATION OF GALACTIC COSMIC RAYS AND ITS ANISOTROPY ACCORDING TO THE DATA OF THE WORLD STATIONS AND INTERPRETATION OF THE RESULTS BASED ON DYNAMIC MODEL OF VARIATIONS. Dorman, L. I.; Shatashvili, L. Kh. (Inst. of Geophysics, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1973-7(Dec. 1964). (In Russian)

A 27-day variation in cosmic rays occurs mainly as a result of modulation of galactic cosmic rays in interplanetary space by an asymmetric flow of magnetic inhomogeneities coming from the sun. It would be desirable to find this 27-day variation in the Z-component of the earth's magnetic field at the poles. Observations on the intensity of the neutron component of cosmic rays on reference days for the first four months of the International Geophysical Year (IGY) at Scott, Barrow and Healy observatories in the north and south hemispheres showed an almost sinusoidal variation with a period close to the period of the sun's rotation. The stations close to 80° latitude showed the 27-day variation more clearly than the stations below 80°. Observations in the northern and southern hemispheres show a time lag in the 27-day effect of the sun's rotation because of the difference in orientation of the two hemispheres with respect to the solar wind of the magnetic inhomogeneities at different times of the year. The 27-day variation in cosmic rays is accompanied by a 27-day variation in magnetic field in the polar regions of the earth. (TTT)

37494 SOME CALCULATION RESULTS FOR ANTICIPATED VARIATION SPECTRA IN DYNAMIC MODEL OF FORBUSH EFFECT. Blokh, G. M.; Blokh, Ya. L.; Dorman, L. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1985-8 (Dec. 1964). (In Russian)

The Forbush effect can be explained by assuming that a solar corpuscular flow is a semipermeable piston moving at a velocity u, which at the front has a regular transverse magnetic field H_{01} and a size L in the direction of flow. There is a regular magnetic field H_{02} in the back part of the corpuscular flow. Magnetic inhomogeneities with a characteristic size l_s at an average distance d from each other with a magnetic field H_s are imposed on the background of the regular magnetic fields. Movement of this semipermeable piston leads to a build-up of cosmic rays in front of the piston and to a decrease in cosmic rays directly behind the magnetic piston. Diffusion of cosmic rays through the sides leads to normal values again. The expected magnitude R of the Forbush effect was calculated for various values of the parameters H_0, l_s, d, L, u, and H_s (it is specified that $R_0 = 300\ H_{01}\ L$). The best agreement with experimental results is obtained at $H_s l_s = 0.5 \times 10^8$ to 5×10^8 Gs-cm, that is, with inhomogeneities of the size $l_s = 10^{12}$ cm, the magnetic field should be 5×10^{-5} to 5×10^{-4} gauss. The magnetic storm of Aug. 29th, 1957 gives a value of $H_s l_s = 10^8$ Gs-cm and $d^3/4\mathrm{Lu}l_s^2 = 1.7 \times 10^{-10}$ sec cm^{-1}. A value of $L = 5.4 \times 10^{12}$ cm is calculated from the time of a fast fall in the intensity of cosmic rays $t_{ff} = 3.6 \times 10^4$ seconds, and from the average velocity of the corpuscular stream $u = 1.5 \times 10^8$ cm/sec. With $d^3 l_s^{-3} = 1$, $l_s = 5.4 \times 10^{11}$ cm and $H_s = 1.8 \times 10^{-4}$ gauss. (TTT)

37495 INVESTIGATION OF ANOMALIES IN THE COSMIC RAY INTENSITIES DURING MAGNETIC STORMS. Kolmeets, E. V.; Pivneva, V. T. (Kirov Kazakh State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1989-92 (Dec. 1964). (In Russian)

An increase in the intensity of the neutron component of cosmic rays was observed during a Forbush-type of decrease. The increase in dn/n does not exceed 1.5%, but if the rate of fall of the intensity is taken into account, the increase is 3 to 3.5%. The increase in the neutron component dn/n is plotted as a function of cosmic ray energy. No increase is observed at cut-off energies > 6 Bev. The energy spectrum from 2.5 to 6.0 Bev has the following exponential form: $\delta d(\epsilon)/D\epsilon = a\epsilon^{-\gamma}$ with $\gamma = 3.61$. The most probable explanation for this increase in neutron component is the arrival of particles in traps which are frozen in the corpuscular flow. The strength of the magnetic field of the trap is estimated as $H = 10^{-5}$ gauss. (TTT)

37496 ASYMMETRY IN COSMIC RAY VARIATIONS. Chirkov, N. P.; Kuz'min, A. I.; Krymskii, G. F. (Inst. of Cosmophysical Studies and Aeronomy, Yakutsk Dept. of Siberian Branch Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 2001-4(Dec. 1964). (In Russian)

Anomalous differences in the neutron component of cosmic rays, in the muon component, and in the Forbush decrease in the muon component were observed at Yakutsk and the bay of Tiksa. The differences between the two stations amount to 40% or more and can not be explained by meteorological effects of the atmosphere. A comparison of the 27-day variation in the muon component at Moscow and in the Antarctic (Mirny) shows that the effect is 40% greater at Mirny than at Moscow. Anomalous differences in the variations are observed at high latitudes as compared with the variations at average latitudes. The spectrum of the primary variation depends on the energy of the incoming particle and on the angle ϕ between the direction of motion of a particle at infinity and the plane of the geomagnetic equator. The dependence of the cosmic-ray variations on the angle ϕ was calculated and was found to agree with actual values. The angular dependence is not contradicted by a mechanism that modulates the cosmic rays by means of a radial interplanetary magnetic field in the plane of the ecliptic. (TTT)

37497 ON THE LATITUDINAL COURSE OF THE FIRST AND SECOND HARMONICS IN DAILY VARIATIONS. Stepanyan, A. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 2016-18(Dec. 1964). (In Russian)

It is assumed that cosmic-ray particles are subjected to diffusion in interplanetary space. If the distance R from the earth to the source causing the anisotropy is large or comparable to the diffusion length λ, the amplitude of the anisotropy decreases substantially. The absence of a daily variation at low energies (<10 Bev) can be explained in this way. The curvature of the particle in the earth's magnetic field must be taken into account in obtaining the latitude dependence of the second harmonic. The presence of an electric field is assumed in explaining the anisotropy. High-energy particles for which $\lambda > R$ are the principal contributors to the anisotropy. The amplitude of the harmonic is a function of the average scattering angle ω in space, the solid angle $d\Omega$, and the anisotropy function L (Φ, ϕ). The latitude variation of the second harmonic differs from that of the first harmonic. The calculated data are in good agreement with the experimental data. The assumption that the daily variation owes its origin to the effect of an electric field and scattering of cosmic rays

readily explains the spectral characteristics of the daily variation, and the latitude dependence of the second harmonic with respect to the first harmonic. (TTT)

37498 INTERPLANETARY DIFFUSION MODEL FOR THE TIME BEHAVIOR OF INTENSITY IN A SOLAR COSMIC RAY EVENT. Krimigis, S. M. (Univ. of Iowa, Iowa City). J. Geophys. Res., 70: 2943-60(July 1, 1965).

The time history of the intensity of several solar cosmic-ray events can be interpreted in terms of a unified interplanetary diffusion model which assumes that the diffusion coefficient $D = Mr^{\beta}$, where r is the heliocentric radial distance and M and β are parameters, which may be dependent on particle energy E. The model is particularly successful in accounting for the decay phases. For the September 28, 1961, event, M varies as $E^{0.33}$; and, assuming spherical geometry, β is equal to 1 for $55 < E < 500$ Mev and decreases rapidly at lower energies. At r = 1 AU the mean free path λ is about 0.081 AU for $E \sim 200$ Mev and 0.15 for E = 23 Mev. The energy dependences of β and λ suggest 0.006 AU as the order of magnitude of the scale size of irregularities in the interplanetary magnetic field. The source spectrum is inferred. The possibility of nonspherical geometry of diffusion is considered, as is the implication of the results with respect to the solar modulation of galactic cosmic radiation. (auth)

37499 COSMIC RAY PRODUCTION BY VIBRATING NEUTRON STARS. Cameron, A. G. W. (Goddard Space Flight Center, New York). Nature, 206: 1342-3(June 26, 1965).

If electrons can be accelerated to high energies in magnetic field interactions with surrounding plasma or by vibrations in the atmosphere, then it should be possible to accelerate ions in a vibrating magnetic field. This assumption led to the hypothesis that vibrating neutron stars may be some of the principal injectors of high-energy cosmic rays into the galaxy. The ions, which would be accelerated cosmic-ray energies by vibrating neutron stars, should certainly include those ions composing the corona. The corona should have the same composition as the photosphere of the neutron star, and if the corona is hot enough to expand in the form of a stellar wind, then the composition of the photosphere may change with time. One test of this cosmic-ray-acceleration process is that the composition of the heavy cosmic ray primaries should be consistent with the changing abundances in the neutron star photosphere. The abundances of 272 elements are based partly on solar spectroscopy, partly on meterite analysis, and partly on rocket measurements of solar cosmic rays. (F.J.H.)

37500 FLUX AND ENERGY SPECTRUM OF PRIMARY COSMIC-RAY ELECTRONS. L'Heureux, Jacques; Meyer, Peter (Univ. of Chicago). Phys. Rev. Letters, 15: 93-6 (July 19, 1965).

An experiment is performed which gives the approximate energy spectrum of the primary electron component of the cosmic radiation. It was carried out by two balloon flights at a time near solar activity minimum. The estimated flux of secondary electrons was subtracted from the total electron flux. Above 500 Mev where little correction is necessary the primary electron spectrum may be represented as a power law. (J.F.P.)

37501 THE ENERGY SPECTRA OF COSMIC RAY NEUTRINOS AT GROUND LEVEL IN THE RANGE 1-1000 Gev. Osborne, J. L.; Said, S. S.; Wolfendale, A. W. (Univ. of Durham, Eng.). Proc. Phys. Soc. (London), 86: 93-9(July 1965).

The intensities of muon and electron neutrinos at ground level were calculated for vertical and horizontal directions, and the muon-neutrino spectrum was found for intermediate angles. The calculations were made for what is regarded as the most likely model of the propagation of the components of the cosmic radiation through the atmosphere, and the dispersion in the neutrino spectrum arising from uncertainties in the model was examined. The intensity of muon neutrinos is found to be greater in the horizontal than in the vertical direction, the ratio increasing with energy from 1.43 at 1 Bev through 2.12 at 10 Bev to 3.70 at 1000 Bev. The uncertainty in the horizontal intensity of muon neutrinos is less than that in the vertical direction. (auth)

37502 ORIGIN OF COSMIC RAYS. INTRODUCTION AND GENERAL REVIEW. Aizu, Ko; Fujimoto, Yoichi; Hasegawa, Hiroichi; Taketani, Mituo (Rikkyo Univ., Tokyo; Waseda Univ., Tokyo; and Gakushun Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), Suppl., No. 30, 2-31(1964).

A general review is presented covering the relation of cosmic rays to galactic structure and the acceleration and composition of cosmic radiation. Electrons, gamma rays, and x rays are covered in some detail. 114 references. (D.C.W.)

37503 ORIGIN OF COSMIC RAYS. PART I. COSMIC RAYS IN GALACTIC AND EXTRAGALACTIC SPACE. Fujimoto, Yoichi (Waseda Univ., Tokyo); Hasegawa, Hiroichi; Taketani, Mituo. Progr. Theoret. Phys. (Kyoto), Suppl., No. 30, 32-85(1964).

A review is presented on the galactic and extragalactic cosmic rays with a particular emphasis on contributions made by Japanese groups. Recent experiments by Japanese laboratories on air showers as well as high energy interactions have disclosed a change in the chemical composition, directional distribution and other properties of cosmic rays as their energy increases. The collaboration in theoretical studies on the evolution of galaxies, which are reviewed in this and accompanied issues, has made it possible to make an estimate on the cosmic-ray production rate from the extragalactic sources and active galaxies. It is shown from these two pieces of information that the extragalactic component dominates in the energy region over $\sim 10^{17}$ ev. A theoretical study on the structure and evolution of the galaxy makes it possible to understand the interrelations between the cosmic rays and other materials in the galaxy. Relations between the halo and the cosmic rays are re-examined, and the conclusions show that one should be free from the current hypothesis which assumes that the galaxy is a simple uniform reservoir of cosmic rays. Several experimental methods are suggested to examine new possibilites. Analyses are made on effects of possible local cosmic-ray sources near the solar system. (auth)

37504 ORIGIN OF COSMIC RAYS. PART II. ACCELERATION MECHANISMS OF COSMIC RAYS. Hayakawa, Satio (Nagoya Univ., Japan); Nishimura, Jun; Obayashi, Haruo; Sato, Humitaka. Progr. Theoret. Phys. (Kyoto), Suppl., No. 30, 86-133(1964).

The mechanisms of charged-particle acceleration in space are investigated systematically. (D.C.W.)

37505 ORIGIN OF COSMIC RAYS. PART III. COMPOSITION OF PRIMARY COSMIC RAYS. Aizu, Hideko; Ito, Kensai; Koshiba, Masatoshi (Tokyo Univ. and Rikkyo Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), Suppl., No. 30, 134-52(1964).

Experimental results on the composition of primary cosmic radiation are reviewed, and their implications are discussed. Isotopic abundances and the information that can be obtained therefrom are stressed. (D.C.W.)

37506 ORIGIN OF COSMIC RAYS. PART IV. COSMIC ELECTRONS AND GAMMA-RAYS. Hayakawa, Satio; Okuda, Haruyuki; Tanaka, Yasuo; Yamamoto, Yoshiaki (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), Suppl., No. 30, 153-203(1964).

Relations among various components of cosmic radiation in the galaxies are considered; and spectra, production rates, and intensities are obtained. Models in which cosmic rays are distributed both uniformly and nonuniformly in the galaxy are considered, together with local sources of gamma rays. (D.C.W.)

37507 ORIGIN OF COSMIC RAYS. PART V. ORIGIN OF COSMIC X-RAYS. Hayakawa, Satio; Matsuoka, Masaru (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), Suppl., No. 30, 204-28(1964).

Several possible mechanisms of cosmic x-ray emission are discussed, and estimates of the x-ray intensities avail-

able through these mechanisms are obtained. It is noted that none of the mechanisms can account for the observed intensity unless some peculiar objects (notably, neutron stars and early-type binaries) are assumed to exist. (D.C.W.)

37508 CONTRIBUTION TO THE ANALYSIS OF MUON ABSORPTION IN MATTER AT LARGE DEPTHS. Vavilov, Yu. N.; Pugacheva, G. I.; Fedorov, V. M. (Lebedev Inst. of Phys., Moscow). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 54-6(July 1965).

Translated from Yadern. Fiz., 1: 80-3(Jan. 1965).

The solutions of the kinetic equation for the penetration of mesons (μ) through thick layers of matter are analyzed. The accuracy is found with which the relative role of the meson (μ) photonuclear losses can be determined by comparing the curves of meson (μ) intensity vs depth in earth and water. The limits imposed by the present uncertainty concerning the photonuclear and electromagnetic losses of meson (μ) energy on the possible values of the meson (μ) energy spectrum index in the region $>10^{12}$ ev are established. (auth)

37509 PION EMISSION AND β DECAY OF A PROTON MOVING IN A MAGNETIC FIELD. Zharkov, G. F. (Lebedev Inst. of Physics, Moscow). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 120-6(July 1965).

Translated from Yadern. Fiz., 1: 173-82(Jan. 1965).

The emission of charged and neutral mesons (π) and the beta decay of a proton moving in a magnetic field are discussed. It is shown that the proton energy losses due to these processes are negligible in comparison with electromagnetic losses for all conceivable energies of the initial proton. (auth)

37510 KOSMICHESKIE LUCHI I PROBLEMY KOSMOFIZIKI (TRUDY PERVOGO VSESOYUZNOGO SOVESHCHANIYA PO KOSMOFIZICHESKOMU NAPRAVLENIYU ISSLEDOVANII KOSMICHESKIKH LUCHEI. YAKUTSK, AVGUSTSENTYABR 1962). (Cosmic Rays and Problems in Astrophysics (Reports of the First All-Union Conference on Astrophysics Concept of Investigation of Cosmic Rays. Yakutsk, Aug.-Sept., 1962)). Shafer, Yu. G., ed. Novosibirsk, USSR, Redaktsionno-Izdatel'skii Otdel Sibirshogo Otdeleniya AN SSSR, 1965. 296p. (CONF-620802)

Forty two papers are included on solar physics and astronomy, neutrino physics, neutrino and cosmogony, the origin of cosmic rays, variations of cosmic rays, electromagnetic conditions, in interplanetary space, solar radiation, primary galactic and extragalactic radiation, wide atmospheric cosmic showers, nuclear interactions and high-energy meson (μ) spectra. Also, meteorological effects in cosmic radiation, the ionosphere, and techniques and methods of investigations, are discussed. (R.V.J.)

Criticality Studies

See also REACTOR TECHNOLOGY — Criticality Studies.

Refer also to abstract 38013.

37511 (HW-84608(p.5-29)) A STUDY OF THREE AQUEOUS HOMOGENEOUS PLUTONIUM NITRATE CRITICAL SPHERES. Reardon, W. A.; Thomsen, D. H. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Two water-reflected 11.5-in.-dia spheres and a 15.2-in.-dia sphere are used in criticality studies on plutonium nitrate solutions. Comparisons are given of the several methods and models for calculating k_{eff}. The RBU code, with its Monte Carlo routines and its diffusion theory code, is compared with the HRG-TEMPEST-SPECTRUM-HFN scheme of cross section preparation and computation in a multigroup, many-region, one-dimensional diffusion theory calculation. (T.F.H.)

37512 (HW-84608(p.81-90)) SUBCRITICAL MEASUREMENTS FOR NUCLEAR SAFETY GUIDANCE. Lloyd, R. C.; Clayton, E. D.; Bierman, S. R. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Cylinders having 5.761 in. ID are spaced on about 24-in. centers in a square planar array, in order to study criticality characteristics of $Pu(NO_3)_4$ solutions in these cylinders. The cylinders are, in one case, stainless steel, and in the other case, Pb–Cd-coated stainless steel, each containing about 1.7 kg Pu. The effects of interstitial concrete blocks and plywood upper and side reflectors are studied. The effects of stacking the vessels two deep are also studied. The number of containers required for criticality in a one-layer array is estimated, by inverse multiplication techniques, to lie between 400 and 500. The results are compared with theoretical estimates. Partially filled cans of PuO_2 powder, each containing about 2.078 kg of PuO_2 and having dimensions of 4.125 in. ID and 5.5 in. high, are stacked into a cubic array. The critical dimensions of this array are determined, by inverse multiplication techniques, to be about 150 cans. The measurements on both nitrate-containing cylinders and plutonia-containing cans are carried out in the far-subcritical regime. (T.F.H.)

Direct Energy Conversion

Refer also to abstract 36633.

37513 (AD-608638) MEASUREMENT OF FLUID PROPERTIES FOR MAGNETOPLASMADYNAMIC POWER GENERATORS. Engineering Department Report No. 4037. Sixth Quarterly Technical Summary Report, August 1 – October 31, 1964. Schneider, R. T. (Allison Div., General Motors Corp., Indianapolis, Ind.). Nov. 17, 1964. Contract Nonr-4104(00). 34p. $2.00(CFSTI).

The major problems in the design of a magnetoplasmadynamic system have been those associated with the gas heater, cesium seeding, helium purification, and helium-cesium separation. These problems are now solved to the degree that reliable operation of the MPD system is achieved. Operation of the present small MPD system yielded sufficient information to permit design of the large test section which is now under construction. Ceramic and tantalum parts were never subject to severe attack by cesium. The quartz window in contact with the hot cesium-helium mixture was found to devitrify immediately. No attack occurred, however, when the windows were sufficiently cooled. It was necessary, therefore, to remove the windows from direct contact with the hot working fluid. The usefulness of the electron heating effect can not be determined before the 50-cm channel is in operation. As preliminary indications, however, the following observations can be reported. It was not possible to observe an increased electron temperature with load resistance down to 100 ohm. Since the measurements reported in previous quarterly summary reports were made, new numerical results became available. From these results it can be seen that an increased electron temperature can hardly be expected when using a load even as low as 100 ohm. (auth)

37514 (AD-609893) BASIC RESEARCH IN THERMIONIC ENERGY CONVERSION. Fourth Annual Technical Summary Report, November 1, 1963-October 31, 1964, Warner, C.; Hansen, L. K. (Atomics International, Canoga, Park, Calif.). Dec. 1964. Contract Nonr-3192(00). 116p. (AI-64-271) $4.00(CFSTI)

Results of the past year's work in a continuing program to investigate basic processes in thermionic energy conversion important to a thermionic nuclear power plant for naval applications are reported. The subject discussed are: ignited mode and ion-rich unignited mode volt-ampere characteristics; boundary conditions and ion generation mechanisms for the ignited mode; retarding field operation of thermionic diodes; ion production in the collector glow mode; and plasma boundary conditions using a generalized Yvon's analysis. (auth)

37515 (IPP-4/17) DER GEGENWARTIGE STAND DER E.H.D.-FORSCHUNG. (The State of E.H.D. Conversion Research Today). Mantel, J. (Institut fuer Plasmaphysik,

G.m.b.H., Garching (West Germany)). Dec. 1964. 24p. Dep.(mn).

A bibliographic research is made which shows the state of the E.H.D. conversion research today. The subject is divided into many paragraphs analized in detail and the future development directions are shown. Quantitative results are mentioned with the aid of a considerable bibliography (about 100 references). (auth)

37516 (NP-15120) LONG LIFE CLOSED LOOP MHD RESEARCH AND DEVELOPMENT UNIT. Quarterly Technical Progress Report No. 11, January 15–April 15, 1965. Hundstad, R. L.; Holmes, F. A.; Fey, M. G. (Westinghouse Electric Corp., Pittsburgh, Pa.). Contract AF33(657)-8311. 20p.

The construction and assembly details of the closed loop test apparatus preparatory to test No. 4 are described. The description, analysis, and design of component parts and a discussion of power lead materials compatability are included. (auth)

37517 (NP-15129) THERMIONIC CONVERTER LIFE AND REPEATABILITY INVESTIGATION. Quarterly Progress Report No. 4, January 1–March 31, 1965. Kamien, C. Z.; vanSomeren, L. (Thermo Electron Engineering Corp., Waltham, Mass.). Contract AF33(615)-1348. 91p. (TE-72-65).

Efforts included scanning of a hot-pressed rhenium emitter, emitter work function measurements of three converters which are on life-test, collector work function measurements of these converters and performance curves of the converters. Metallurgical and chemical analysis were performed on a number of converters which failed during the period. Two converters are being operated on a steady state basis and the lead converter has passed 2500 hours at the present. Two additional converters are operating on a cyclic basis of 55 minutes ON and 35 minutes OFF. The lead cycling converter has passed 600 cycles. All converters operate at 0.7 volts and an emitter temperature of 2000°K. At these conditions the highest output obtained is 18 W/cm^2 and the maximum power output is 26 W/cm^2 at 0.4 volts. (auth)

37518 (NYO-3429-3) THE DEVELOPMENT OF AN IMPROVED THERMIONIC ENERGY CONVERTER. Third Quarterly Technical Report. (Radio Corp. of America, Lancaster, Pa. Direct Energy Conversion Dept.). Apr. 1965. Contract AT(30-1)-3429. 32p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Studies are being made on reservoirless thermionic converters. The feasibility of operating these converters with the envelope at or near the collector temperature was shown. ^{134}Cs was used to fill certain converters to determine the distribution of cesium within the converter and the rate of diffusion in the exposed materials. The reservoirless converters were divided into two groups related to the envelope temperature at pinch-off and during operation. The low-temperature converters were pinched off with the minimum envelope temperature only slightly higher than the optimum cesium reservoir temperature. These converters were characterized by relatively constant power output during their lifetime although they showed a strong sensitivity to envelope temperature. The high-temperature converters were pinched off with average envelope temperatures at least 150°C higher than optimum cesium reservoir temperatures. Their performance was characterized by power outputs relatively independent of minimum envelope temperature. However, a slow reduction in power output during life due to loss of cesium vapor was observed. (M.C.G.)

Elementary Particles and Radiations

Refer also to abstracts 36929 and 37383.

37519 (CALT-68-37) APPLICATIONS OF THE ALGEBRA OF CURRENT COMPONENTS. Dashen, Roger F.; Gell-Mann, Murray (California Inst. of Tech., Pasadena). May 1965. Contract AT(11-1)-68. 11p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

Some applications of the nonchiral U(6) × U(6) group for the hadrons at rest and the related algebraic properties of the weak and electromagnetic currents are discussed. Only the (56, 1)$^+$ baryons B and the (6, $\bar{6}$)$^-$ mesons M are considered. The known Lorentz transformation properties of the U(6) × U(6) operators, as space integrals of components of scalar, tensor, vector, and axial vector densities, are used to examine the matrix elements of the operators between moving states of the particles composing the U(6) × U(6) representations, assuming mass degeneracy among the supermultiplet members. Predictions for electromagnetic form factors are discussed. The application of the hybrid group U(6) to collinear S-matrix elements is considered. It is found that the more successful predictions of approximate higher symmetry for the 36 M mesons and the 56 B baryons can be obtained by using the positive parity algebra of U(6) × U(6) as a rough symmetry of the states at rest. (M.J.T.)

37520 (CAR-882-8) π^- + p INTERACTIONS AT 646 Mev. Oliver, John D. (Carnegie Inst. of Tech., Pittsburgh, Pa. Dept. of Physics). Jan. 1965. Contract AT-(30-1)-882. 134p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

A study of π^-p reactions at 646 Mev was made using a 14-inch liquid hydrogen bubble chamber. Approximately 6600 good events were analyzed and the following cross sections were obtained: $\sigma_{(elastic)} = 17.56 \pm 0.43$ mb, $\sigma(\pi^0\pi^-p) = 4.65 \pm 0.17$ mb, $\sigma(\pi^-\pi^+n) = 7.14 \pm 0.23$ mb, $\sigma_{neut.} = 11.78 \pm 0.43$ mb, $\sigma(\pi^-\pi^+\pi^0n) = 0.33 \pm 0.04$ mb, and $\sigma(\pi^-p\pi^-\pi^+) = 0.08 \pm 0.02$ mb. This gives a total cross section of 41.54 ± 0.82 mb. The elastic differential cross section was fitted to a 5th order polynomial in $\cos\theta^*$ with coefficients $a_0 = 0.27 \pm 0.02$, $a_1 = 1.48 \pm 0.11$, $a_2 = 3.86 \pm 0.22$, $a_3 = -0.29 \pm 0.53$, $a_4 = -0.65 \pm 0.28$, and $a_5 = 1.69 \pm 0.52$ (mb/ster). The fact that a 5th order curve was needed indicates that partial waves up to F_5 are present. The inelastic reactions are dominated by production of the N*(1238) isobar and were fitted to the model of Olsson and Yodh. The model failed to explain the angular distributions of the reaction products and also failed to explain the $M_{\pi^-\pi^+}$ plot. However, it was successful with the other two-body effective mass plots. (auth)

37521 (CERN-65-22) THEORETICAL PROBLEMS IN STRONG INTERACTIONS AT HIGH ENERGIES. Lectures Given at CERN in 1964 by L. Van Hove. Dietz, K.; Mueller, V.; Wilkin, C. (European Organization for Nuclear Research, Geneva (Switzerland)). June 4, 1965. 106p. Dep.(mn).

Collisions of hadrons (mesons and baryons) are considered for the range of energies above 5 Bev (lab), where all cross sections appear to be smooth functions of energy and momentum transfer. Basic definitions and formulas are presented for two-body elastic and inelastic amplitudes and cross sections. A phenomenological description is given of small-angle high-energy elastic scattering and partial wave amplitudes, and the optical model is considered. The scattering amplitudes are expressed in terms of the S-matrix. Inelastic two-body collisions are discussed in terms of exchanged quantum numbers, considering the case of pion-nucleon scattering. The dominance of exchange amplitudes in elastic scattering is discussed. The analytic properties of scattering amplitudes are used to derive relations between cross sections for the scattering of particles A and B and of the antiparticle A and the particle B; the Pomeranchuk theorem is derived as a special case. A brief sketch on the introduction of dispersion relations on the basis of the analyticity properties of the scattering amplitude T(s,t) in s (t fixed) is given. The search for a precise mathematical condition for characterizing the high-energy region is discussed. A short description and analysis of measurements of the real part of the scattering amplitude at high energies is given, and results are compared with predictions from dispersion theory. The relation between elastic and inelastic collisions at high energies is treated, exploring the possibility of elastic scattering as the shadow of

inelastic collisions. The overlap function for the complete description of inelastic collisions and their effect on elastic scattering is discussed qualitatively. Experimental questions whose answers are essential for further progress are suggested. (M.J.T.)

37522 (CONF-650410-2) K^-p INTERACTIONS AT 940 Mev/c AND THEIR BEARING ON $Y^*(1765)$. Technical Report No. 456. Yodh, G. B. (Maryland Univ., College Park. Dept. of Physics and Astronomy). May 1965. Contract AT(40-1)-2504. 34p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From American Physical Society, Washington, D. C.

Data are presented from the following momenta: 900, 922, 940, 960, and 985 Mev/c. The experimental technique involved and the bearing of the results on the $Y^*(1765)$ are discussed. A discussion of the decay channels $\Lambda\pi^0$, $\bar{K}n$, $\Lambda\pi^+\pi^-$ is included. Total cross sections are presented. (M.O.W.)

37523 (COO-1371-1) COUPLED PARTIAL DIFFERENTIAL EQUATIONS FOR TRINUCLEON "RADIAL" WAVE FUNCTIONS. Bolsterli, M. (Los Alamos Scientific Lab., Univ. of California, N. Mex. and Minnesota Univ., Minneapolis. School of Physics). [nd]. Contract AT(11-1)-1371. 38p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The radial wave equations for the state $T = \frac{1}{2}$, $J^\pi = \frac{1}{2}^+$, corresponding to the bound state of the trinucleon, are derived; sixteen coupled partial differential equations in three variables are obtained. (M.J.T.)

37524 (COO-1428-12) STRANGE PARTICLE PRODUCTION IN 2.7 Gev/c π^-p INTERACTIONS. Miller, D. H.; Kovacs, A. Z.; McIlwain, R. L.; Palfrey, T. R.; Tautfest, G. W. (Purdue Univ., Lafayette, Ind.). [1965]. Contract AT(11-1)-1428. 22p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A total of 1514 strange particle events were analyzed in a sample of 30,000 pictures of incident 2.7 Bev/c π^- in the 72-in. hydrogen bubble chamber. Strong resonance production is observed, particularly $K^*(888)$, $Y_1^*(1385)$, and $Y_0^*(1405$ and $1520)$. In general, baryon systems are peaked sharply backward in the center of mass system consistent with one-particle exchange. Partial cross sections and a study of all final states are presented. The total strange particle cross section at this energy is calculated to be 1.49 ± 0.07 millibarns. (auth)

37525 (CU-1932-241) SOME FEATURES OF K° DECAY: THE $\Delta S = \Delta Q$ RULE, AND THE $|\Delta I| = \frac{1}{2}$ RULES FOR LEPTONIC AND THREE-PION DECAYS. Franzini, P.; Kirsch, L.; Schmidt, P.; Steinberger, J.; Plano, R. J. (Nevis Labs., Columbia Univ., Irvington-on-Hudson, N. Y.). May 1965. Contract AT(30-1)-1932. 34p. (CU-241; NEVIS-135; R-504) Dep.(mn); $2.00(cy). 1(mn) CFSTI.

In a sample of ~36,000 K° and $\bar{K}^\circ$ mesons produced in antiproton annihilations in a liquid hydrogen chamber, the K° leptonic decay rate, the time distribution of K° leptonic decays, as well as the $K^\circ \to \pi^+ + \pi^- + \pi^0$ decay rates were studied. These results permit tests of the $\Delta S = \Delta Q$ rule, CP violation in leptonic decays, as well as tests of the $\Delta I = \frac{1}{2}$ rule for both leptonic and non-leptonic decays when compared with published results on other charge channels. The data, within their experimental error, are found to be consistent with all three rules as well as with no large-scale CP violation in K° leptonic decay. (auth)

37526 (CU-1932-243) PRODUCTION OF PIONIC RESONANCES IN $\pi^+ + p$ INTERACTIONS AROUND 2.5 Bev/c (thesis). Gelfand, Norman (Nevis Labs., Columbia Univ., Irvington-on-Hudson, N. Y.). June 1965. Contract AT(30-1)-1932. 123p. (NEVIS-137) Dep.(mn); $4.00 (cy), 2(mn) CFSTI.

Submitted to Columbia Univ., New York.

An exposure of the 20-in. liquid hydrogen bubble chamber to π^+ mesons at laboratory momenta of 2.34, 2.62, and 2.90 Bev/c was studied. Production of the ρ^0 in the reaction $\pi^+ + p \to \pi^+ + p + \pi^+ + \pi^-$ was observed. The production of the ρ^0 is often accompanied by the $\frac{3}{2}$, $\frac{3}{2}$ isobar. In the reaction $\pi^+ + p \to \pi^+ + p + \pi^+ + \pi^- + \pi^0$ the $\pi^+\pi^-\pi^0$ decay modes of the ω^0 and η^0 mesons were observed. The ω^0 is produced frequently with an isobar. The analysis of the decay of the ω^0 confirms the 1^{3-} assignments for spin, parity, and G parity. The data are in agreement with the $0^\pm$ spin, parity, and G parity for the η^0. The width of the ω^0 is found to be less than 20 Mev, while the width of the η^0 is less than 10 Mev. The two pion decay rate for the ω^0 is found to be less than 2% of the decay into three pions. (auth)

37527 (DESY-65/2) THE POINCARÉ-INVARIANT PHASE SPACE WITH FULL KINEMATICS. Satz, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr. 1965. 17p. Dep.(mn).

A Poincaré-invariant s-particle phase space integral with full kinematics, $\Omega_s(W^2, L^2)$, is formulated as a generalization of the non-relativistic phase space integral at constant energy, momentum, angular momentum, and center of mass. For large particle numbers s, the integral $\Omega_s(W^2, L^2)$ is evaluated covariantly with the central limit theorem; the summation $\Sigma_{s=3}^{\infty}(1/S!)\,\Omega_s(W^2, L^2)$ is then carried out for high energies ($m/W \to 0$). (auth)

37528 (IC/65/27) S-MATRIX THEORY OF ELECTROMAGNETIC INTERACTIONS (WITH TOPICS IN WEAK AND GRAVITATIONAL INTERACTIONS). Barut, A. O. (International Centre for Theoretical Physics, Trieste (Italy)). Mar. 1965. 70p. (CONF-650218-1). Dep.(mn).

From International University Sessions on Nuclear Physics, Schladming, Austria.

It is shown that an S-matrix theory can be formulated for long range interactions, due to considering the scattering matrix in the case of charged particles, between the reducible representations of the Lorentz group, i.e., representations containing charged particles and photons, and due to the smallness of the coupling constants of electromagnetic and gravitational interactions. The equivalence of S-matrix theory and perturbation theory is shown, and the results of renormalized perturbation theory including radiative corrections are reproduced by S-matrix methods. Some properties of the S-matrix are reviewed, including amplitudes, quantum principle, invariance, conservation laws, spin, helicity, analytic decomposition, symmetry transformations, and unitarity. Electromagnetic interactions and some typical processes are considered. Related problems with spin-$\frac{1}{2}$ and spin-2 massless particles are discussed, considering gravitational interactions and neutrino processes. (M.J.T.)

37529 (IC/65/65) BARYON OCTET SCATTERING IN U(12). Akyeampong, D. A.; Delbourgo, R. (International Centre for Theoretical Physics, Trieste (Italy)). July 5, 1965. 34p. Dep. mn.

The predictions of $\tilde{U}(12)$ for the reactions $NN \to NN$ and the crossed processes $N\bar{N} \to N\bar{N}$ that follow from contact interactions in conjunction with pole terms are compared with the available experimental data, with particular reference to forward scattering and the threshold limit. The results in the annihilation channel are fairly satisfactory, whereas those in the direct channel are decidedly not so at the low energies where the comparison is effected. With structureless amplitudes the calculations represent the first step of a more complete dispersion treatment which correctly restores the unitarity of the amplitude. (auth)

37530 (JINR-E-2108) THE OBTAINING OF APPROXIMATE EQUATIONS FOR THE SCATTERING MATRIX ELEMENTS IN THE RELATIVISTIC THREE-BODY PROBLEM. Shelest, V. P.; Stoyanov, D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 7p. Dep.(mn).

Approximate equations were obtained for the elements of the three-body scattering matrix in the case of the particle scattering on the bound two-body states with strong and weak coupling. (auth)

37531 (JINR-P-2098) O SOSTAVNOI MODELI MEZONOV NA OSNOVE URAVNENII TIPA BETA-SOLPITERA. (On a Composite Model of Mesons on the Basis of the Bethe-Salpeter Type Equations). Bogolubov, P. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 15p. Dep.(mn).

The quark-antiquark system was considered on the basis of the Bethe-Salpeter type equations. An equation was ob-

tained which allows one to determine the electric and magnetic form factors of mesons. (auth)

37532 (JINR-P-2126) ZAMECHANIE OTNOSITEL'NO UNIVERSAL'NOSTI ZAVISIMOSTI SECHENII RASSEYANIYA PRI VYSOKIKH ENERGIYAKH OT POPERECHNOGO IMPULSA. (On Universality of Scattering Cross Section Dependence on Transverse Momentum at High Energies). Lyubimov, A. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1965. 5p. Dep.(mn).

It is shown that if for scattering on the nucleon of other particles there holds an exponential dependence of the differential cross sections on the transverse momentum which has been established for proton-proton collisions, then the angular distribution of elastic backward scattering should be peaked. The experimental data on π^+ p-scattering fit this prediction. (auth)

37533 (LA-3322) BIBLIOGRAPHY OF CROSS SECTION AND SCATTERING DATA FOR THE REACTIONS D + D AND T + D. Winsor, R. V. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Mar. 9, 1965. Contract W-7405-eng-36. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

References to cross section and scattering data for the D + D and D + T reactions for incident energies up to 1 Mev are presented. The report and journal literature since 1955 is covered. Pertinent Los Alamos Scientific Laboratory reports are included no matter what their age. Some references to classified literature are included. The references are arranged alphabetically by first author or by corporate author and by title when there is more than one reference by any one author. (auth)

37534 (LAL-1138) POLARIZATION OF RECOIL PROTONS FROM ELECTRON-PROTON SCATTERING AT 950 Mev. Bizot, J. C ; Buon, J. M.; Lefrancois, J.; Perez Y Jorba, J.; Roy, P. (Laboratoire de l'Accelerateur Lineaire, Univ. de Paris, Orsay (France)). June 1965. 39p. Dep. mn.

The recoil proton polarization in elastic high energy electron scattering on proton was measured in order to check the validity of first Born approximation in this reaction. The transverse polarization is proportional to the imaginary part of the second order term (two photon exchange term). 950 Mev electrons were scattered in a liquid hydrogen target at about 90° c. of m. The recoil protons were analysed by a magnet system. Their polarization was then measured in a polarimeter constituted by a carbon scatterer and 4 spark chambers. The two transverse components of the polarization were calculated by a method derived from maximum likelihood. The component perpendicular to the scattering plane was found to be 0.040 ± 0.027. The transverse component in the scattering plane was found to be 0.000 ± 0.028. (auth)

37535 (LAL-1139) PHOTOPRODUCTION OF π^+ ON PROTON AT 0° IN THE ENERGY RANGE 300 TO 600 Mev. Bizot, J. C.; Perez y Jorba, J.; Treille, D. (Laboratoire de l'Accelerateur Lineaire, Univ. de Paris, Orsay (France)). June 1965. 11p. Dep.(mn).

Cross sections for the 0° π^+ photoproduction on protons between 300 and 600 Mev were measured, using a bremsstrahlung beam from the electron linear accelerator and employing a scheme of triple focusing spectrometer, lead absorbers, and plastic scintillation counters in coincidence to eliminate positrons formed in the interaction. Results are presented and compared with previous measurements and calculations. (M.J.T.)

37536 (N64-26098) UNITARY SYMMETRY AND WEAK INTERACTIONS. Gourdin, M. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). May 1964. 29p. (CONF-640509-1). Dep. mn.

From Colloquium on Theoretical Physics, Bordeaux.

A general discussion is presented of the currents (electromagnetic and weak) and the unitary symmetry encountered in weak interactions. Also discussed are these processes: (1) leptonic–leptonic decay of pseudoscalar mesons and baryons and high-energy neutrino reactions: and (2) nonleptonic–the nonleptonic hamiltonian, kaon – pion pion disintegration, nonleptonic decay of baryons, and radiative weak decays of baryons. (auth)

37537 (NP-15147) LOW ENERGY $\bar{K}$-NUCLEON INTERACTIONS AND THE APPARENT STRONG VIOLATION OF CHARGE INDEPENDENCE IN K^--PROTON ABSORPTION REACTIONS. Chand, Ramesh (Wayne State Univ., Detroit, Mich. Dept. of Physics). [1964]. 19p.

In the zero-range boundary conditions method of Dalitz and Tuan for the discussion of low energy K^--proton reactions, the apparent strong violation of charge independence hypothesis in the calculations of hyperons production rates, due to the inclusion of ($\bar{K}^0$, K^-) and (n,p) mass differences, is investigated. Also, the results of Sakitt's zero-range analysis on low energy interactions of K^--mesons in hydrogen bubble chamber are discussed. (auth)

37538 (NYO-3399-36) ORIGIN OF SYMMETRY AND SELF-COUPLING OF VECTOR MESONS. Musto, R.; O'Raifeartaigh, L.; Rao, P. S. (Syracuse Univ., N. Y. Dept. of Physics). [1964]. Contract AT(30-1)-3399. 31p. Dep.(mn); $2.00(cy), 1(mn) CFSTI

The case of a multiplet of vector mesons interacting with themselves by means of a trilinear interaction is considered from the point of view of the Smushkevich equations, which can be considered either as a subset of a set of self-consistency equations, or as a consequence of the Smushkevich Principle, which states that the interaction of the mesons with each other should be such that the nondegeneracy of the meson masses persists after the interaction is switched on. It is shown that for multiplets of low order, the Smushkevich equations determine the number of particles in the multiplet, and it is conjectured that this is generally true. The physically interesting case of eight vector mesons is considered in detail. It is shown that if the coupling is anti-symmetric in all indices and the charge is conserved, then the Smushkevich equations imply that the interaction is SU(3)–invariant. If the interaction is not completely anti-symmetric the algebra becomes much more complicated, but if one simplifies it by assuming isotopic spin and hypercharge conservation, one obtains a plausibility argument in favor of SU(3) invariance. (auth)

37539 (ORNL-P-1386) SPACETIME AND ELEMENTARY PARTICLE GROUPS. Melvin, M. A.; Roskies, R. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 14p. (CONF-650619-1) Dep.(mn); $1.00(cy), 1(mn) CFSTI

From 2nd Topical Conference on Resonant Particles, Athens, Ohio.

The possibilities of deriving mass-splitting formulas from a conjectured coupling of the spacetime symmetry associated with isolated particles, with their approximate internal symmetry are discussed. Theory of the hydrogenic spectrum is used to illustrate the extent to which one might expect to find mass-splitting formulas by guessing a group of higher symmetry in which manifest symmetries are embedded. Problems are discussed which arise if mass splitting may be interpreted in terms of the existence of a supersymmetry group G within which spacetime and internal symmetries are coupled nontrivially, i.e., if G does not contain the mass-determining spacetime group as a direct product factor. Indications are that barring a possible radical redefinition of mass, the explanation of mass splitting is not to be found by embedding the Poincaré group into a finite parameter Lie group G. (auth)

37540 (TID-21929) ON THE RADIATIVE HYPERON DECAYS, $\Sigma^+ \rightarrow n + \pi^+ + \gamma$ (thesis). Technical Report No. 451. Li, Ming Chiang (Maryland Univ., College Park. Dept. of Physics and Astronomy). Apr. 1965. Contract AT(40-1)-2504. 117p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

The observation of the $\Sigma^+ \rightarrow n + \pi^+ + \gamma$ radiative-decay spectra is proposed as a method of determining the s- or p-wave nature of the Σ pionic decay. The previous theoretical treatment is based on a phenomenological interaction that neglects all form factor effects. Calculations are made to investigate the sensitivity of the theoretical predictions to structure effects using two models, a self-

consistent pole model that includes the $\Sigma^+ \to p + \gamma$ vertex in a natural way and a loop model that serves as a demonstration of the radiative influence of a virtual light particle. The results show that the simple phenomenological calculation is not changed significantly. Hence, the reliability of the radiative-decay method to determine the s- or p-wave nature of Σ pionic decay is improved. (auth)

37541 (UCRL-7953-T) AN EVALUATION OF THE DISPERSION RELATIONS OF PHOTOPRODUCTION. Finkler, Paul (Purdue Univ., Lafayette, Ind. and Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 31, 1964. Contract W-7405-eng-48. 55p. Dep.(mn); $3.00(cy), 2(mn) CFSTI

A modification of the Omnès method is used to solve the singular integral equations for the 3-3 partial wave amplitudes of photoproduction. The effects of multi-pion production are assumed to be negligible. The method requires a knowledge of the phase at all energies. Consequently, it is necessary to treat the corresponding pion-nucleon scattering problem to determine the effect of the high-energy behavior of the phase on the solution for the scattering amplitude at low energies. The sharply resonant nature of the problem suggests an approximation in the form of solution, rather than in the Born terms, which leads to relatively simple expressions for the ratios of the 3-3 photoproduction amplitudes to the scattering amplitude and for integrals involving the 3-3 amplitudes. In addition, a modified Chew-Low formula can be derived which should satisfactorily represent the 3-3 phase shift throughout the resonance region. Finally, the cross sections are calculated in the 3-3 approximation and the results compared with experiment. (auth)

37542 (UCRL-11333(Rev.)) A MEASUREMENT OF $d\sigma(0)/d\Omega$ FOR THE REACTION $\pi^- + p \to \pi^0 + n$ AT 900 Mev IN THE 72-INCH HYDROGEN BUBBLE CHAMBER. Natapoff, Alan; Bang, Vo Xuan (Lawrence Radiation Lab., Univ. of California, Berkeley). May 1964. Contract W-7405-eng-48. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The pion-nucleon dispersion relations, based on the principle of microscopic causality, permit the calculation of the real parts of the forward amplitudes for π^--p and π^+-p scattering at a fixed energy, if the corresponding total cross sections are known as a function of energy. In addition, the forward differential cross section, $d\sigma^{ce}(0)/d\Omega$, for charge exchange ($\pi^- + p \to \pi^0 + n$) was calculated previously, assuming charge independence. Experimental values for the latter, therefore, can help to determine the validity of the principle of microscopic causality. A low-statistics measurement of $d\sigma^{ce}(0)/d\Omega$ at 1.03 Bev/c in the 72-inch hydrogen bubble chamber is described. The π^- beam came from the Bevatron, and the secondary neutrons were detected when subsequent elastic scatters $n + p \to n + p$ yielded visible stopping protons. The real events were separated from the spurious by a Boolean algebraic method that reduced the set of all events to a sum of a small number of physically significant sets. The residual background fraction was estimated at 10% by a computer simulation technique using the known beam distribution and a pure sample of background events. The bubble chamber, so used, detected about 5% of the secondary neutrons emitted in the charge-exchange reaction. There were 12 experimental events in three intervals lying in the range $0.84 \leq \cos\theta_{\pi^0}^{c.m.} \leq 0.96$. A zero-constraint, least-squares fit of the distribution yielded the estimate $d\sigma^{ce}(0)/d\Omega = (3.65 \pm 1.93)$ mb/sterad. This result is consistent with the predictions based on the dispersion relations. (auth)

37543 (UCRL-11408) THE METHOD OF BOOLEAN SIGNATURES: AN APPLICATION OF BOOLEAN ALGEBRA TO THE STATISTICAL ANALYSIS OF EXPERIMENTS. Natapoff, Alan (Lawrence Radiation Lab., Univ. of California, Berkeley). May 5, 1964. Contract W-7405-eng-48. 21p. Dep.(mn); $1.00(cy), 1(mn) CFSTI

A method is presented that simplifies the physical content of an experimental result by removing a maximal number of redundant variables. A set of N primary binary variables is postulated to characterize each "event" of the sample, and an N-bit binary signature is constructed that summarizes the behavior of each event relative to these N variables. For well-chosen variables and an unbiased experimental sample, the sets of signatures occurring frequently can be uniquely decomposed into physical subsets if an appropriate kind of physical relation holds among the variables. This gives a global picture of the correlations among the basic variables, facilitates the separation of real from background events and gives a physical picture of the physical channels contributing to the experimental distribution. The Boolean minimization approach initiated by Quine is used and the calculations are performed, for large problems, by a computer. A detailed example from high-energy physics is given. (auth)

37544 (UCRL-11548) ANGULAR DISTRIBUTIONS FOR $\pi^- p \to \pi^0 n$ AT 315 AND 371 Mev. Kurz, Richard J.; Lind, Don L. (Lawrence Radiation Lab., Univ. of California, Berkeley). July 6, 1964. Contract W-7405-eng-48. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An analysis of the angular distribution of the reaction $\pi^- p \to \pi^0 n$ incorporating four classes of data is reported. They are: (a) previously published γ-angular distributions at $T_{\pi^-} = 317$ and 371 Mev (T_{π^-} = incident π^- kinetic energy); (b) the neutron differential cross section at $T_{\pi^-} = 374$ Mev in the range $84 \leq \theta_n^* \leq 133$ deg^2 (θ_n^* = c.m.-system neutron angle = $\pi - \theta_{\pi^0}^*$, * denotes c.m.-system variable), (c) neutron differential cross sections at $T_{\pi^-} = 313$ and 371 Mev in the range $21 \leq \theta_n^* \leq 123$ deg^3; and (d) the differential cross section at $\theta_{\pi^0}^* = 0$ deg calculated from the forward-direction, fixed-momentum-transfer dispersion relations for pion nucleon scattering. A least-squares analysis was performed to fit these data to the c.m.-system differential cross section in the form: $d\sigma/d\Omega^* (\cos\theta_{\pi^0}^*) = \Sigma_{l=0}^{N} a_l P_l (\cos\theta_{\pi^0}^*)$. (M.O.W.)

37545 (UCRL-12211-T) UNITARITY CORRECTIONS TO PERIPHERAL P-P SCATTERING BELOW 400 Mev (thesis). Arndt, Richard Allen (Lawrence Radiation Lab., Univ. of California, Livermore. Jan. 1, 1965. Contract W-7405-eng-48. 86p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

Submitted to Univ. of California, Berkeley.

Proton-proton partial wave amplitudes for $l \geq 1$ and lab kinetic energies below 400 Mev are fit with a collection of single-particle exchanges taken in Born (fixed-pole) approximation. Since the Born terms are real, and consequently nonunitary, a correction term is added which makes the full amplitude unitary and at the same time satisfies the appropriate dispersion relation and threshold condition. The nature of this correction term and its association with a strip approximation to the Mandelstam representation is discussed. The gross structure of the partial wave amplitudes is found to be approximately given by a π meson ($J = 0^+$, $T = 1$, $g_\pi^2 \approx 13.5$, $M_\pi \approx 135$ Mev), an S_0 meson ($J = 0^+$, $T = 0$, $g_{S_0}^2 \approx 1.8$, $M_{S_0} \approx 400$ Mev), and an effective vector meson ($\rho + \omega$ effect) ($g_V^2 \approx 1.7$, $(f/g)_V \approx 3$; $M_V \approx 760$ Mev). It is further found that the relatively small unitarizing corrections play an essential role in determining the goodness of fit, but do not much alter the pole parameters determined from search. (auth)

37546 (UCRL-12383) COMPARISON OF RECENT PION-NUCLEON PHASE SHIFT ANALYSES. Roper, L. David (Lawrence Radiation Lab., Univ. of California, Livermore). Apr. 26, 1965. Contract W-6405-eng-48. 74p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

An attempt is made to evaluate which of several pion-nucleon phase-shift analyses in the 300- to 700-Mev region best fits the experimental data. The various solutions were compared by fitting them with the parameterization used in one analysis, and a χ^2 determination was used to improve the fit. Results are presented, giving phases shifts, absorption parameters, and real and imaginary parts of partial wave amplitudes. Polarizations for the various solutions are also compared. The behavior of the polarizations and the spin-rotation parameters as functions of energy is shown for the best solution, that of Auvil et. al. (Phys. Letters 12, 76, 1964) combined with the P_{11} and S_{11} resonances from other solutions. (M.J.T.)

37547 (UCRL-16026) K_{e4} DECAY AND THE DETERMINATION OF π-π SCATTERING PHASE SHIFTS (thesis). Maksymowicz, Alexander T. (Lawrence Radiation Lab., Univ. of California, Berkeley). May 1, 1965. Contract W-7405-eng-48. 93p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The study of correlations in K_{e4} decays can give unique information on low-energy π-π scattering. By using an appropriate system of energy and angle variables to describe the decay $K^+ \rightarrow \pi^+\pi^-e^+\nu$, a particularly simple set of angular correlations for this process is defined. It is shown that the measurement of these angular correlations at any fixed π-π cms energy allows a model-independent determination of the difference between the S- and P-wave π-π scattering phase shifts, $\delta_0 - \delta_1$, at that energy to be made. Information about the average value and sign of $\delta_0 - \delta_1$ can be obtained from a measurement of the same correlations averaged over the energy spectrum. Measurement of the average correlations is particularly suited to the testing of any model of low-energy π-π scattering. Discussions are given of the model in which S-wave scattering is described by the Chew-Mandelstam effective range formula and the effects of the final state interaction between the pions by the relativistic Watson enhancement factor. If this model is adequate, the suggested measurements should yield a value for the S-wave scattering length in the I = 0 state. By using unitary symmetry considerations to estimate the vector current contribution to the K_{e4} decay rate, it is shown that it is very small compared to that of the axial current and thus its neglect in the model calculation is justified. The effects of a possible violation of time-reversal invariance are investigated; it is found that, in general, it would greatly complicate the analysis. (auth)

37548 (JPRS-29641(p.1-22)) REGGE ACTION OF HIGH SINGULARITY POTENTIAL AND NON-REGIONAL POTENTIAL. Tai, Yaun-pen. Translated from K'o Hsueh T'ung Pao, No. 2, 95-106(1965).

The asymptotic behavior of the scattering amplitude is studied, using concrete field-theoretic models. Discussions are given of the Regge behavior of the scattering amplitude for original potential poles with second or higher order, of the Regge poles of the z^{-4} repulsive potential, and of the Regge behavior of a type of nonregional potential. For the first case, it is proved that the S-matrix $S(\lambda,k)$ is half-pure in the whole λ-plane and that $S(\lambda,k)-1 = O(\log\lambda/\lambda)$, for $k > 0$ and $\lambda \rightarrow \infty$ in the region $|\arg\lambda| < \pi/2$, where $\lambda = l + \frac{1}{2}$, l is the angular momentum, and k is the momentum. It is also found that the nonregional potential $S(\lambda,k)$ is half-pure on the right side of the λ-plane. Results are presented on the asymptotic characteristics of $S(\lambda,k)$ for $\lambda \rightarrow \infty$, on the analysis of the variable k, and on the locations of the poles. (M.J.T.)

37549 ASYMPTOTIC BEHAVIOR OF SCATTERED WAVES. Roskies, Ralph (Oak Ridge National Lab., Tenn.). Am. J. Phys., 33: 552-6(July 1965).

The relation between the Fourier transform of a scattered wave and its asymptotic behavior at large distances from the scatterer is derived rigorously and is generalized to spaces of arbitrary dimension. Using this result, a simple derivation of the partial-wave expansion is given. Also a concise representation for the Laplacian on a sphere in n dimensions is obtained. (auth)

37550 UNITARITY AND PARTIAL WAVE AMPLITUDES. Kantor, Paul B. (Brookhaven National Lab., Upton, N. Y.). Ann. Phys. (N. Y.), 33: 196-213(June 17, 1965). (BNL-8691)

In the last few years considerable effort has been invested in the single boson exchange approach to the nucleon-nucleon interaction. A crucial problem in this scheme is the calculation of amplitudes satisfying unitarity from non-unitary Born terms, and various methods have been applied. The present work is a comparison of these methods based on applying them to some simplified problems with no inelastic effects and numerically evaluating the resulting expressions for k cot δ. S-wave scattering from an exponential and a separable Yukawa potential is considered, and the following methods are compared: N/D; Determinantal Approximation; Schrödinger equation; "Heitler damping" or "K-matrix" method. It is found that these methods do not, in general, agree at all well. Some conclusions about the dependence of the first, second, and fourth solutions on remote singularities are drawn; it is found that it is not small. The significance of these results is discussed. (auth)

37551 THE SU_3 MODEL AND STRONG COUPLING. Dullemond, C. (Universiteit, Nijmegen, Netherlands). Ann. Phys. (N. Y.), 33: 214-45(June 17, 1965).

The hierarchy is obtained of energy levels of baryon excited states in a baryon-scalar meson coupling model using strong coupling techniques. The inneraction is SU_3 invariant (unbroken) and is an arbitrary mixture of F- and D-type coupling, indicated by a mixing parameter α. Certain specific values for α are excluded from consideration. The computation is done for the case of very strong coupling, such that all excited states now appear as bound states. It is hoped that for weaker coupling the hierarchical order of levels is maintained. No low-lying singlet appears; the ground state is an octet. For $0 < \alpha < \frac{1}{2}$ there is a low-lying decuplet level fairly constant in that interval as compared to the octet level and minimal for $\alpha = \frac{1}{4}$. There is a $\{27\}$ which is maximal for $\alpha \sim \frac{1}{4}$. A $\{10^*\}$ varies rapidly and is high for $\frac{1}{4} < \alpha < \frac{1}{2}$. A $\{35\}$ level is again fairly constant in the interval $0 < \alpha < \frac{1}{2}$ and rather low, but still higher than $\{27\}$. (auth)

37552 THE STRUCTURE OF THE DISTRIBUTIONS IN LOCAL FIELD THEORY AND THE ASYMPTOTIC BEHAVIOR OF SCATTERING AMPLITUDES. van Hieu, Nguyen (Joint Inst. for Nuclear Research, Dubna, USSR). Ann. Phys. (N. Y.), 33: 428-442(July 1965).

A new class of distributions which is wider than the class of tempered distributions and is suitable for formulating the microcausality principle in the local field theory is considered. It is proved that, owing to the microcausality principle and the local character of the fields, the scattering amplitudes increase more slowly than any linear exponential when energy tends to infinity in the complex plane. Some physical consequences of this behavior are also considered. (auth)

37553 ELASTIC AND ELECTROMAGNETIC PROTON INTERACTIONS AT 3 Tev. McCusker, C. B. A.; Peak, L. S.; Woolcott, R. L. S. (Univ. of Sydney). Australian J. Phys., 18: 277-82(June 1965).

The results of a line scan, in nuclear emulsion, of protons of average energy 3 tev are presented. No elastic scatters were detected in the scanned length of 594 cm. The probability of detecting an elastic scatter in emulsion is calculated, and hence the proton-proton elastic cross section at 3 tev is found to be 5 mb. Five examples of proton direct-pair production were found in the above path length. It is shown that this result is consistent with the predictions of quantum electrodynamics. (auth)

37554 PHOTOPRODUCTION OF π^+-MESONS ON HYDROGEN. Aleksandrov, Yu. M.; Grushin, V. F.; Zapevalov, V. A.; Leikin, E. M. (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR, 160: 796-8(Feb. 1, 1965). (In Russian)

The angular distribution of mesons(π^+) from the reaction $\gamma + p \rightarrow \pi^+ + N$ was measured at $E_\gamma = 230$ Mev. A collimated beam of bremstrahlung radiation from a synchrotron with a maximum energy of 264 Mev stuck a liquid hydrogen target. The mesons(π^+) of the requisite energy were separated out according to range in a telescope consisting of 3 scintillation counters. Triple coincidences from π-μ decay in the 3rd scintillation counter were counted to give an average value $\bar{N}_u$ which was converted to the number of mesons(π^+) $\bar{N}_\pi$ stopped in the 3rd counter. The gamma dose was determined by means of three thin-walled ionization counters calibrated periodically by a quantometer. The differential cross section for the photoproduction of mesons(π^+), for a given angle in the center-

of-mass system ($d\sigma/d\Omega$) was found to be 7.15 ± 0.34 at 38°, 11.30 ± 0.33 at 82°, 12.10 ± 0.31 at 90°, 12.75 ± 0.45 at 116°, 14.64 ± 0.44 at 138°, and 13.66 ± 0.33 microbarns at 146° (center-of-mass system). (TTT)

37555 THE PARTICLES OF MODERN PHYSICS. Frisch, O. R. Electron. Power, 11: 153-4; 163(May 1965).

A brief survey is presented on the discovery, production, and weak interactions of elementary particles. (L.B.S.)

37556 THE MAGIC DIRECTION. Roy, T. C. (Jadavpur Univ., Calcutta). Indian J. Phys., 39: 99-100(Feb. 1965).

An analysis of polarization data is made using the magic direction. A few interesting properties of the parity-changing term and their effects on the magic direction are shown. (J.F.P.)

37557 ON THE RATIO OF THE MASSES OF THE NUCLEON AND THE ELECTRON AND ON THE EXISTENCE OF NEW ELEMENTARY PARTICLES WITH CONSIDERABLE MASSES. Kalitsin, N. St. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 13: 81-94(1965). (In Bulgarian).

It is noted that the ratio of the masses of the nucleon and the electron is equal to the ratio of the constants of the strong and electromagnetic interactions. On the basis of the analogy between the electron and its photon field and the nucleon and its meson(π) field, the existence of particles with masses hundreds of times greater than the nucleon mass is proposed. The energy output of quasars is discussed in terms of reactions involving nuclei composed of massive fermions. (D.C.W.)

37558 CHARGE EXCHANGE p-n INTERACTION AT 6.2 Gev. Markov, P. K.; Peeva, A. T. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk, 13: 215-19(1965). (In Bulgarian)

Two nuclear photoemulsion stacks were exposed to a 6.2-Bev proton beam at right angles to the surface of the layers. The upper limit for the cross section of the charge exchange p-n interaction in the region from 1.3 to 10.5° in the center-of-mass system was determined to be ≤0.23 ± 0.06 mb. (auth)

37559 ANALYSIS OF N + N → N + N + π PROCESSES BETWEEN 1 AND 3 Gev. Becherrawy, T.; Kessler, P. (College de France, Paris). J. Phys. (Paris), 26: 217-25 (May 1965). (In French)

The reaction N + N → N + N + π was studied in a peripheral-isobaric model where the resonance N^*_{33} was treated as an elementary particle of spin $^3/_2$. Introducing a form factor with one single arbitrary parameter for the exchanged pion, a great number of experimental curves were fitted: i.e., energy distributions of outgoing neutrons and protons (results of Barnes et al.) and momentum distributions of outgoing protons at fixed angle (results of Chadwick et al.) for the reactions p + p → p + n + π^+ and p + p → p + p + π^0 at various incident kinetic energies between 1 and 3 Bev. (auth)

37560 PROPAGATION OF DE BROGLIE WAVES IN SPACE-TIME. Kulhanek, J. Nuovo Cimento (10), 38: 1178-85(Aug. 1, 1965).

The relativistic action function can be considered as a system of wave 3-surfaces of the progressive wave; the wave 4-velocity of this wave is equal to the ray 4-velocity. The situation created by the equality of the two 4-velocities is examined. The first fundamental form of space-time is identified as an elementary wave 3-surface. The relativistic action function regarded as the wave 3-surface is an envelope of these elementary wave 3-surfaces. The relativistic Hamilton formalism is a theory of this wave process in space-time. The same wave process (a wave field) in space-time may be considered as a unified foundation on which could be based the treatment of motion particles and propagation of light waves in 3-space. (auth)

37561 SOME REMARKS CONCERNING COUPLED ND^{-1} EQUATIONS. Nath, P.; Srivastava, Y. N. (Univ. of California, Riverside). Nuovo Cimento (10), 38: 1192-1200(Aug. 1, 1965).

Some related questions in coupled reactions are studied. An extension of the Omnes' function for multichannel processes is obtained, which reduces to the Fredholm determinant of the integral equations for the nonrelativistic case. It is especially suited towards obtaining a Levinson theorem for coupled cases. With the assumption that the input is symmetric, a proof is given to show that the scattering matrix from ND^{-1} equations is symmetric and independent of the subtraction points when n^2 different subtractions are chosen for an n-channel problem. An approximate first-order scattering matrix is obtained, which is symmetric as well as subtraction-point-independent. (auth)

37562 OVERLAPPING CHANNELS AND MULTI-CHANNEL PHENOMENA. Rajaraman, R.; Susskind, L. (Cornell Univ., Ithaca, N. Y.). Nuovo Cimento (10), 38: 1201-19(Aug. 1, 1965).

The problem of multichannel scattering is studied in the framework of potential theory. Some of the difficulties that arise in high-energy physics due to the overlapping of channels are simulated. The problem is treated in such a way that the different channels are separated and identifiable in the initial, final, and intermediate states. A basis system is constructed which serves this purpose better than the usual plane-wave states of the different channels. The procedure used also clarifies the validity of treating particles as elementary in some approximation when they may actually be composite. The relevance to strong-interaction physics is discussed. (auth)

37563 QUANTUM ELECTRODYNAMICS IN THE NONLINEAR SPINOR THEORY AND THE VALUE OF SOMMERFELD'S FINE-STRUCTURE CONSTANT. Duerr, H. P.; Heisenberg, W.; Yamamoto, H.; Yamazaki, K. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cimento (10), 38: 1220-42(Aug. 1, 1965).

In the nonlinear spinor theory the assumption of a ground state asymmetrical under the isospin group requires the existence of bosons of rest mass zero according to the theorem of Goldstone. Actually the photon plays the role of the Goldstone particle. Hence for this assumption to be consistent the eigenvalue equation of the photon must have a solution at mass zero. Therefore this eigenvalue equation should contain a continuous parameter which can be changed until the equation is fulfilled for the rest mass zero of the photon. The average mass of the leptons acts as this parameter; Johnson emphasized that the equations of quantum electrodynamics are invariant under a scale transformation, if the masses of the leptons are of purely electromagnetic origin. This scale invariance persists in the nonlinear spinor theory, therefore the lepton mass values, from the point of view of quantum electrodynamics, may be multiplied by an arbitrary scale factor. When the average mass of the leptons is fixed by the condition that the rest mass of the photon should be zero, the coupling constant $e^2/\hbar c = \alpha$ can be calculated by the methods used by Dhar and Katayama or by Yamazaki for the $\pi\mathcal{N}$ or $\eta\mathcal{N}$ coupling. The first approximation leads to an average lepton mass of ~40 Mev and for the coupling constant to the result $\alpha \approx 0.386(\lambda\!\!\!^{-}_{\text{pion}}/\lambda\!\!\!^{-}_{\text{nucleon}})^2 \approx {}^1/_{120}$, which is to be compared with the empirical value $\alpha \approx {}^1/_{137}$. (auth)

37564 LIMITING PROCEDURES FOR SINGULAR POTENTIALS. [PART] I. Cornille, H. (CERN, Geneva). Nuovo Cimento (10), 38: 1243-78(Aug. 1, 1965).

For singular repulsive potentials, as well as for regular potentials, the S-matrix is the limit of the ratio of the two Jost solutions when the radial coordinate goes to zero. It is shown that the S-matrix is the limit of sequences, each term of the sequences being the ratio of the perturbation expansion of the same order of the two Jost solutions. It is shown that these sequences converge to the S-matrix if the order of the perturbation expansion and the radial coordinate are connected in a certain manner. Some remarks are given about cut-off procedures in potential scattering: (a) Can the physical quantities be obtained if the whole contribution given by the cut-off is taken into account? (b) Can the cut-off and the order of perturbation be connected? (c) Is the recent prescription of summing up the first leading singularities a valid approximate

method? (d) In the Fredholm's type of solution can the same kind of divergence exist both in the numerator and in the denominator when the cut-off goes to zero? (e) Can the cut-off going to zero and the order of the Fredholm's determinants going to infinity be connected both in the numerator and in the denominator in such a way that the physical solution is obtained as the limit of convergent sequences? (auth)

37565 A GENERAL METHOD FOR INVESTIGATION OF THE SCATTERING BY "NONPHYSICAL" POTENTIALS. Lomsadze, Yu. M. (Uzhgorod State Univ., Ukrainian SSR). Nuovo Cimento (10), 38: 1291-1302(Aug. 1, 1965).

A general method for investigation of scattering by practically arbitrary nonphysical potentials $\lambda V(r)$ with short range is given, illustrated by the example of nonrelativistic scattering but applicable also, after corresponding modification, to relativistic and Bethe-Salpeter potential scatterings. A Volterra integral equation is obtained for the partial wave function $\psi_\lambda(l,s,r)$, and an explicit form for the partial wave amplitude $f_\lambda(l,s)$ is derived which is convenient for investigation of the analytic properties of $f_\lambda(l,s)$ with respect to different variables. It is shown that $f_\lambda(l,s)$ inevitably has an unmoving singularity of the root (and only root) type in the variable λ at the point $\lambda = 0$ and, with the same inevitability, an essential singularity in the variable s at infinity. This latter makes impossible both the Mandelstam and the one-dimensional dispersion relations for the total amplitude $T_\lambda(l,s)$. The situation for realistic field-theory scattering is discussed. (auth)

37566 ON SIMPLE LIE GROUPS OF RANK 3. Loupias, G.; Sirugue, M.; Trotin, J. C. (Universite, Marseille). Nuovo Cimento (10), 38: 1303-25(Aug. 1, 1965).

Properties of simple Lie algebras of rank three are investigated in view of physical applications; more precisely, dimensions, weight diagrams, decompositions with respect to regular subalgebras, and decomposition of products of representations are given for the lowest order irreducible representations. Some techniques to deal with these problems even in the case of higher rank algebras are explained. (auth)

37567 ON THE SOLUTIONS OF PARTIAL-WAVE DISPERSION RELATIONS. Martin, A. (CERN, Geneva). Nuovo Cimento (10), 38: 1326-41(Aug. 1, 1965).

Two results are obtained on partial wave dispersion relations. The method used, in both cases, avoids the N/D separation and takes into account inelastic effects. First, a criterion for the existence of bound states is obtained as a sum rule over the left-hand cut contribution. It is explicitly shown that inelasticity favors the formation of bound states. Secondly, the one-particle-exchange model for the unphysical cut contribution is shown to be inconsistent with unitarity and threshold behavior if the partial wave under consideration has an angular momentum larger than the spin of the exchanged particle. However, it is remarked that approximate solutions may satisfy both unitarity and threshold behavior. (auth)

37568 ON THE INCLUSION OF THE (27) REPRESENTATION INTO THE EFFECTIVE LAGRANGIAN FOR NONLEPTONIC $\Delta Y = \pm 1$ DECAYS. Bailin, D. (Clarendon Lab., Oxford). Nuovo Cimento (10) 38: 1341-54(Aug. 1, 1965).

Relations are derived resulting from assuming (27) dominance and CP invariance. Mixed lagrangians involving both (8) and (27) representations are also considered. It is found that $K_1^0 \to 2\pi$ is forbidden by all such lagrangians. (auth)

37569 THE ERIKSEN-LIKE FORM OF THE FOLDY-WOUTHUYSEN TRANSFORMATION FOR THE PHOTON. Beckers, J. (Universite, Liege). Nuovo Cimento (10), 38: 1362-6(Aug. 1, 1965).

The Foldy-Wouthuysen transformation for free or interacting photons is obtained in an Eriksen-like form from a (6×6) real formulation of Maxwell equations. (auth)

37570 THE DEUTERON POLE IN THE NUCLEON-NUCLEON SCATTERING AMPLITUDE. Dosch, H. G. (Universitaet, Heidelberg); Mueller, V. F. Nuovo Cimento (10), 38: 1377-84(Aug. 1, 1965).

The deuteron is treated as a bound state in nucleon-nucleon scattering. The coupled $l = 0$ and $l = 2$ amplitudes of the $J = 1$, $I = 0$ NN state are treated within the framework of relativistic partial-wave dispersion relations using the matrix extension of the N/D technique in order to solve the coupled integral equations. As left-hand singularities the contributions of one-boson-exchange terms are taken into account. Furthermore, the triplet scattering length is introduced as a subtraction constant. (auth)

37571 TWO-PARTICLE AND MANY-PARTICLE CHANNELS IN HIGH-ENERGY COLLISIONS. Bialas, A.; Van Hove, L. (CERN, Geneva). Nuovo Cimento (10), 38: 1385-1406(Aug. 1, 1965).

Previous investigations of high-energy collisions of hadrons in the asymptotic region of constant cross sections are continued. Two models proposed earlier, one in which inelastic collisions give rise to many particles with a minimum of correlation between them, the other in which they consist entirely of isobar excitation of one or both incident particles, are combined together, and the resultant shadow scattering is compared with the experimental characteristics of elastic scattering. Excellent agreement is obtained if most of the inelastic collisions are of the uncorrelated many-particle type, only a small fraction of the inelastic cross section corresponding to isobar excitation without further particle creation. The method used exploits unitarity of the S-matrix and crossing symmetry of the isobar excitation channels which are assumed to be dominated by $C = 1$ exchange. The isobar excitation channels are analyzed in terms of a simple K-matrix. The effect of the uncorrelated many-particle channels is described by means of an overlap function which determines the angular distribution of elastic scattering and isobar excitation. Its effect on the latter is found to be a simple generalization of the distorted wave Born approximation. (auth)

37572 RENORMALIZABILITY OF HIGHER-SPIN THEORIES. Lukierski, J. (Univ. of Wroclaw). Nuovo Cimento (10), 38: 1407-10(Aug. 1, 1965).

The behavior in momentum space of the propagators $D^c_{AB}(S; m; p)$ describing massive particles with spin $S \geq 1$ is modified, leading to $D^c_{AB}(S; m; p) \sim p^{-2}$ for $S = 1,2,3, \ldots$, and $\sim p^{-1}$ for $S = \frac{1}{2}, \frac{3}{2}, \ldots$, for arbitrary spin S, by introducing the unconditional spin projection operator. The method is briefly described in the case $S = 1$. An extended Stueckelberg formalism, with two additional scalar fields, is introduced and the unconditional spin projection operators for integral and half-integral S are obtained. (M.J.T.)

37573 QUANTUM AND CLASSICAL COHERENCE OF STATIONARY MODES. Troup, G. J. (Monash Univ., Victoria, Australia). Nuovo Cimento (10), 38: 1411-14 (Aug. 1, 1965).

Evidence is introduced that the semiclassical and quantum-mechanical treatments of coherence are equivalent for stationary fields, in the sense that the quantum-mechanical functions can be deduced directly from the classical functions. Only a single mode of the electromagnetic radiation field—i.e., a single cell in phase space—is considered. (M.J.T.)

37574 LOCAL CONSERVATION AND THE GAUGE INVARIANCE GENERATED BY GOLDSTONE PARTICLES. Umezawa, H. (Istituto di Fisica Teorica, Naples and CNR, Naples). Nuovo Cimento (10), 38: 1415-19(Aug. 1, 1965).

Attention is drawn to the important positive roles played by Goldstone particles in theories of dynamical breakdown of symmetries. It is found that the invariance of a symmetry-breaking theory under the γ_5 transformation is not destroyed but reappears as the gauge transformation of the Goldstone particle B. The pair approximation, considering the chain diagrams only, is used to derive the pseudovector helicity current. The argument is illustrated by the Nambu-Heisenberg model, although the conclusions seem to be quite general. (M.J.T.)

37575 NOTE ON RELATION BETWEEN FOLDY-WOUTHUYSEN AND LORENTZ TRANSFORMATIONS.

Bryden, A. D. (London Univ.). Nuovo Cimento (10), 38: 1420-5(Aug. 1, 1965).

A brief outline is given of some of the general results derived by Pursey's formalism for the construction of all possible manifestly covariant wave equations for Dirac particles—i.e., equations in which the wave functions are tensors or spinors—and for the expression of these wave functions in terms of the basis functions of irreducible representations of the inhomogeneous Lorentz group. It is shown that, for the case of spin ½, Pursey's formalism gives rise to the Dirac equation in spinorial form and reproduces the relation obtained by Jehle and Parke between the Foldy-Wouthuysen transformation and the Lorentz transformations to the rest frame for the two-component spinors. (M.J.T.)

37576 ON THE CLASSICAL SPIN MOTION OF SPIN-ONE PARTICLES. Rafanelli, K. (Queens Coll., Flushing, N. Y.). Nuovo Cimento (10), 38: 1426(Aug. 1, 1965).

A correction to the equation for the motion of the spin tensor, derived by Sniatiycki using the WKB method for asymptotic solutions to the spin-one Proca equations, is pointed out; the corrected equation is identical to that of Bargmann, Michel, and Telegdi, derived previously from the Dirac and Kemmer equations. The relation of the spin tensor with the spin pseudovector and its orthogonality property are mentioned. (M.J.T.)

37577 EXCITATION OF NUCLEON ISOBARS IN PROTON AND ELECTRON SCATTERING. Clegg, A. B. (Oxford Univ.). Nuovo Cimento (10), 38: 1433-7(Aug. 1, 1965).

The elementary particle production process A + B → C + D + E, proceding by the mechanism of emission of a virtual particle F according to the reactions A → C + F, and F + B → D + E, is considered. It was shown previously how a kinematic variation of the cross section for the reaction F + B → D + E, which depends on the orbital angular momentum involved, can provide an explanation of the observed production of the 1510- and 1690-Mev nucleon isobars in p-p interactions at larger momentum transfers than expected from the simple peripheral model. It was also found that there is a similar production of these isobars at large momentum transfers in electron scattering. It is shown how there is a possible relation between these two results, indicating a possible extension of the vector meson-photon analogy, which is involved in the magnetic dipole excitation of the 1238-Mev isobar, to the production of the 1510- and 1690-Mev isobars by quadrupole excitation. (M.J.T.)

37578 THE DIFFRACTION OF VAVILOV-CHERENKOV RADIATION. Sedrakyan, D. M. Opt. Spectry. (USSR) (English Transl.), 18: 206-8(Mar. 1965).

Translated from Opt. i Spektroskopiya, 18: 360-3(Mar. 1965).

The radiation emitted by a charged or a current-carrying wire moving in a refractive medium of dielectric constant E past A semi-infinite metallic screen was studied. In such a medium the velocity of the wire may exceed the phase velocity of light, $v > c/\sqrt{E}$; this results in Cherenkov radiation. The presence of the metallic screen causes the Cherenkov radiation field of the wire to undergo diffraction. Equations were solved to find the diffracted field of the Cherenkov radiation. (M.C.G.)

37579 POLARIZATION EFFECTS IN ELASTIC ELECTRON-DEUTERON SCATTERING. Tung, Wu-Ki (Yale Univ., New Haven). Phys. Rev., 139: B547-53(Aug. 9, 1965).

A relativistic calculation is made of the effects of polarization in elastic electron-deuteron scattering in order to provide a theoretical basis for the complete measurement of the deuteron electromagnetic form factors. The S matrix is calculated in the first Born approximation using the helicity representation for the incoming and outgoing particle states. The density matrix for the final state is obtained for an arbitrary initial state in the deuteron spin space. The two polarization experiments most likely to be feasible in the near future are examined in detail. These are measurement of the spin alignment of the recoil deuteron for scattering of unpolarized electrons on unpolarized deuterons; and measurement of the differential cross section for scattering of unpolarized electrons on polarized deuterons. In particular, it is found that the interference term between the deuteron charge and quadrupole-moment form factors can lead to a measurable effect of 10 to 15% for a "reasonable" deuteron tensor polarization analyzer, or for a polarized deuteron target with percentage tensor polarization greater than about 0.1. These experiments provide a method for the separation of the dueteron charge and electric quadrupole form factors. Measurement of the latter provides a sensitive test of the D-state structure of the deuteron. (auth)

37580 COMMENTS ON RELATIVISTIC SUPERMULTIPLET THEORIES. Weinberg, Steven (Univ. of California, Berkeley). Phys. Rev., 139: B597-601(Aug. 9, 1965).

It is proved that no well-behaved group of unitary operators on physical Hilbert space can have irreducible representations containing all spin states of the particles involved. It is shown that the recently proposed U(12) symmetry evades this theorem by acting on the "generalized M function," rather than on the physical Hilbert space. Some other possible evasions are also discussed. (auth)

37581 SINGULAR POTENTIALS AND REGULARIZATION. Calogero, F. (Universita, Rome and Instituto Nazionale di Fisica Nucleare, Rome). Phys. Rev., 139: B602-6(Aug. 9, 1965).

Let V(r) be a potential repulsive and singular at the origin, and A a physical quantity (say, the scattering length) associated with it. Let $V(r,\alpha)$ be a regulated version of the potential V(r); $V(r,\alpha)$ is nonsingular for $\alpha > 0$ and coincides with V(r) for $\alpha = 0$. Let $A(\alpha)$ be the corresponding scattering length. It is usually assumed that A(0) = A. Simple counterexamples are presented, namely, cases when A and A(0), although both well defined and finite, are different. The existence of these counterexamples sheds doubt on the validity of a theorem given by Khuri and Pais. This doubt is substantiated by noting that the proof of the theorem contains an unjustified exchange of two limiting processes. (auth)

37582 FERMION DECAY INTO SPIN-½ FERMION PLUS SPIN-0 BOSON. Button-Shafer, Janice (Univ. of California, Berkeley). Phys. Rev., 139: B607-16(Aug. 9, 1965). (UCRL-11903(Rev.))

The decay of a fermion of arbitrary spin into an unstable spin-$\frac{3}{2}$ fermion plus a spinless boson is treated with density-matrix techniques. The formalism described is an extension of that developed by Byers and Fenster for the decay of a fermion into spin-½ and spin-0 particles. Decay distributions are completely described for three successive decay processes. Various tests for spin and parity of the parent fermion are suggested. (auth)

37583 SUM RULES FOR COUPLING CONSTANTS IN BROKEN SU(6) SYMMETRY. Chan, C. H.; Sarker, A. Q. (Univ. of California, San Diego, La Jolla). Phys. Rev., 139: B626-9(Aug. 9, 1965).

The baryon-meson vertex is considered in the broken SU(6) symmetry scheme, in particular the spin-$\frac{1}{2}^+$-pseudoscalar meson, and the spin-$\frac{3}{2}^+$-spin-$\frac{1}{2}^+$-pseudoscalar meson vertices. The coupling constants are given in terms of four independent parameters which are then determined from the known values of the coupling constants $g^2_{\pi NN}/4\pi(\simeq 15)$ and $g^2_{\Sigma\Lambda K}/4\pi(\simeq 1)$ and the decay widths $\Gamma(N^{*++} \to p + \pi^+) = 120$ Mev and $\Gamma(\Xi^{*-} \to \Xi^- + \pi^0) = 2.5$ Mev. The remaining coupling constants (apart from those which can be obtained from charge independence) are expressed in terms of 20 sum rules. The predictions from these sum rules are then compared with experimental results and are found to be in good agreement with them. (auth)

37584 PHASE-SHIFT ANALYSIS OF ELASTIC PION-NUCLEON SCATTERING. Hull, M. H. Jr.; Lin, F. C. (Yale Univ., New Haven). Phys. Rev., 139: B630-45(Aug. 9, 1965). (YALE-1807-24)

A many-energy analysis of π-N scattering data in the energy range from 20 to 340 Mev was carried out by fitting phase shifts in S, P, D, and F states in gradient searches. Semiphenomenological analyses, with F-wave phase shifts calculated from approximate evaluations of pion-nucleon dispersion relations and D-wave phase shifts similarly obtained for the lower energy range, were equally successful in fitting the data. Particular attention was paid to the possibility of obtaining a unique set from all possible sets allowed by data. Several sets of phase shifts have been found. One of these is preferred by data and by comparison with dispersion-theoretical calculations. Comparisons with other recent analyses are made. (auth)

37585 ABSORPTIVE PROCESSES AND SINGLE-PARTICLE EXCHANGE MODELS AT HIGH ENERGIES. I. GENERAL THEORY. Durand III, Loyal; Chiu, Yam Tsi (Yale Univ., New Haven). Phys. Rev., 139: B646-66 (Aug. 9, 1965).

It has been shown by several authors that the effect of competition from other open channels can materially effect the predictions of single-particle exchange models for high-energy particle reactions. The general theory of these absorptive effects in the distorted-wave Born approximation is discussed in detail for several situations in nonrelativistic potential scattering using the WKB approximation. The case of many coupled two-body channels is considered in detail. If the transition potential in question is of short range compared with most of the other potentials, the distorted-wave Born approximation for the S matrix in the presence of this potential is given by $S = S_0 + A^T S^B A$, where S_0 is the S matrix in the absence of the perturbing potential, S^B is the Born approximation for the transition S matrix, and A is a known unitary matrix such that $S_0 = A^T A$. Under appropriate circumstances, A may be approximated by the square root of the S matrix; one then obtains the generalization to the many-channel problem of a result derived previously for two channels, $S = S_0 + S_0^{\frac{1}{2}} S^B S_0^{\frac{1}{2}}$. For long-range transition potentials, S is given by $S = S_0 + \frac{1}{2}[S_0 S + S^B S_0]$. These results do not depend on the details of the potentials. It is therefore plausible that they may be used in relativistic calculations. The generalizations necessary for the application to relativistic particle reactions, including the effects of the particle spins, are discussed in detail. The properties of the rotation coefficients of the second kind encountered in this analysis are also discussed, and the general Fourier-Bessel integral representation of the scattering amplitudes for particles with spin is considered. Finally, the possibility of adapting the results to a K-matrix formalism, appropriate when the distorted-wave Born approximation fails, is discussed briefly. (auth)

37586 STATIC BARYON RESONANCES WITHIN THE SU(6) 700. Griffith, Richard W. (California Inst. of Tech., Pasadena). Phys. Rev., 139: B667-70(Aug. 9, 1965).

The SU(6) 700 representation is discussed, especially as a possibility for static-model baryon resonances. As an example, mass sum rules for the spin-$\frac{5}{2}^+$ resonances are derived, and the approximations are displayed. New features in the application of SU(6) symmetry result [relative to previous SU(3) treatment], especially the presence of mixing. (auth)

37587 ANALYSIS AND MODEL OF LOW-ENERGY ΛK^0 PRODUCTION. Hoff, G. T. (Univ. of Chicago). Phys. Rev., 139: B671-83(Aug. 9, 1965).

The low-energy ΛK^0 production data are analyzed under the assumption of a K^*-exchange background. An interesting result is found; namely, that the observed anomaly in the polarization and slight shoulder in the cross section at 829 Mev is apparently due to a narrow F_5 resonance located at 1647 Mev. The parameters of this resonance are determined from the data by adding its contribution to a model proposed previously by the author, which gave fairly good results above and below the energy of the anomaly, after modifying the contribution from a P_5 resonance included in that model by taking into account the proper threshold behavior. Fits to all the data up to 1.03 Bev/c (900 Mev) (the region of validity of the previous model) are given. The result obtained for the product of relative partial widths agrees remarkably well with that predicted by unitary symmetry for a member of an octet with an asymmetry parameter of 0.674 (Carruther's model). It is also found that the P_5 resonance (if it exists) can not be a member of an octet, but it has to belong to either a $\overline{10}$ or 27 representation, if the F_5 resonance belongs to an octet. Experiments which might confirm or deny the existence of these resonances are suggested. Further, our method of analysis is extended to a more general type of background which includes contributions from the nucleon pole and baryon exchange terms. (auth)

37588 SEPARABLE POTENTIALS AND COULOMB INTERACTIONS. Harrington, David R. (Rutgers Univ., New Brunswick, N. J.). Phys. Rev., 139: B691-5(Aug. 9, 1965).

The scattering of two nonrelativistic charged particles interacting via a short-range separable potential and a repulsive Coulomb potential is studied. The "nuclear" phase shift is given by an explicit formula, identical to that for the neutral-particle case except that the separable potential functions are replaced by their Coulomb-modified counterparts. A simple one-term S-wave separable potential of the Yamaguchi type is used to illustrate this result. A perturbation theory is developed and used to relate the proton-proton scattering length and effective range and the corresponding neutron-neutron parameters. The results is in reasonable agreement with experiment and with previous calculations using local potentials. (auth)

37589 FURTHER REMARKS ON THE IMPOSSIBILITY OF A SCALAR-MESON BOOTSTRAP. Collins, P. D. B. (Univ. of California, Berkeley). Phys. Rev., 139: B696-701(Aug. 9, 1965). (UCRL-11974)

Some lacunae in a previous argument that a single particle can not form a self-sustaining or "bootstrap" system are filled. A method is proposed of treating the "potential" that reconciles the Mandelstam iteration procedure with the Regge asymptotic behavior of the double spectral function, by making a subtraction of the S-wave discontinuity. This leads to a more general argument that unitarity and crossing symmetry put a very stringent limit on the magnitude of the coupling strength and exclude the possibility of even producing the bound state corresponding to the particle. (auth)

37590 TWO-BODY EFFECTIVE-MASS SPECTRA IN THE PRODUCTS OF THE REACTION $\gamma + p \rightarrow p + \pi^+ + \pi^-$ AND THE σ RESONANCE. Del Fabbro, R.; De Pretis, M.; Jones, R.; Marini, G.; Odian, A.; Stoppini, G.; Tau, L. (Laboratori Nazionali del Sincrotrone, Rome). Phys. Rev., 139: B701-11(Aug. 9, 1965).

By means of spark chambers and counters, the (π^+,π^-) and $(\pi^\pm,p)$ invariant-mass spectra obtained from the products of the interaction $\gamma + p \rightarrow p + \pi^+ + \pi^-$ were measured. They are in disagreement with the Cutkosky-Zachariasen model which takes into account the effect of the $\frac{3}{2}, \frac{3}{2}$ nucleon isobar. To fit the data a π-π final-state enhancement factor with resonant behavior was introduced. The resonance energy is around 380 Mev. (auth)

37591 LAGRANGIAN FORMULATION OF $\tilde{U}(12)$ SYMMETRY AND THE BARGMANN-WIGNER EQUATIONS. Guralnik, G. S.; Kibble, T. W. B. (Imperial Coll. of Science and Tech., London). Phys. Rev., 139: B712-19(Aug. 9, 1965).

The problem of finding Lagrangian functions which yield the Bargmann-Wigner equations is discussed, and is solved explicitly for the case of third-rank spinors. The formalism provides a field-theoretic realization of the $\tilde{U}(12)$ symmetry theory proposed by Salam, Delbourgo, and Strathdee. A general expression for the residue at the physical particle pole corresponding to an arbitrary multiplet is given, in a simple form which exhibits the symmetries of the theory. The propagators for the 143 and 364 representations are analyzed in detail. (auth)

37592 LOW-ENERGY K^--MESON INTERACTIONS IN HYDROGEN. Sakitt, M. (Univ. of Maryland, College Park

and Naval Research Lab., Washington, D. C.); Day, T. B.; Glasser, R. G.; Seeman, N.; Friedman, J.; Humphrey, W. E.; Ross, R. R. Phys. Rev., 139: B719-28(Aug. 9, 1965). (BNL-9099).

Low-energy meson (K^-) interactions in hydrogen are studied in the following channels: $K^- + p \rightarrow K^- + p$, $K^- + p \rightarrow \Sigma^- + \pi^+$, and $K^- + p \rightarrow \Sigma^+ + \pi^-$; and cross sections, as a function of momentum, are presented in the region of 60-300 Mev/c K^- laboratory momentum. These cross sections, combined with existing data, are used to fit the zero-effective-range theory of Dalitz and Tuan. Two possible solutions are obtained; the preferred one agrees with previous higher energy data. The favored solution also suggests an S-wave bound state at 1410 Mev, which could be associated with the Y_1^0 at 1405 Mev whose spin is still undetermined. Various properties of the two solutions are presented for K^-p interactions and K_2^0p interactions. (auth)

37593 ISOTROPIC AND NONISOTROPIC π-μ DECAYS. Hulubei, H. (Inst. of Atomic Physics, Bucharest); Friedlaender, E. M.; Nitu, R.; Visky, T.; Anghelescu, D.; Auslaender, J. S. Phys. Rev., 139: B729-32(Aug. 9 1965).

Nuclear emulsion experiments on π-μ decay at rest are described, and the muon angular distribution is compared with that obtained in previous experiments under radically different conditions. In the present experiment the pions were produced in a magnetic field of 10^4 gauss, the angle of emission was 180°, the kinetic energy was ~50 Mev and no filter was interposed between target and stack (flight path 765 cm), whereas in the previous experiment there was no field, the emission angle was 0°, the kinetic energy was ~300 Mev, and the beam traversed 685 cm, of which 17 cm were of Cu. The muon angular distribution in this experiment is isotropic and significantly different from that of the previous one. Thus, pion history seems to have an essential influence on the properties of part of the decaying particles. (auth)

37594 POLARIZATION OF THE RECOIL PROTON FROM π^0 PHOTOPRODUCTION IN HYDROGEN. Maloy, J. O. (California Inst. of Tech., Pasadena); Peterson, V. Z.; Salandin, G. A.; Waldner, F.; Manfredini, A.; Friedman, J. I.; Kendall, H. Phys. Rev., 139: B733-46(Aug. 9, 1965).

The polarization of the recoil proton in neutral single-pion photoproduction from hydrogen, $\gamma + p \rightarrow p + \pi^0$, was measured for pion center-of-mass angles near 90° at 7 photon energies from 450 to 900 Mev. The polarization rises to a maximum of 0.58 near 600 Mev and is still 0.42 at 900 Mev. The sign of the polarization is negative in the sense of $k \times q$, where k is the photon momentum and q is the pion momentum. The measured values are given as functions of laboratory photon energy and cm pion angle as follows: 450 Mev, 109°, -0.16 ± 0.14; 525 Mev, 84°, -0.36 ± 0.19; 585 Mev, 86°, -0.58 ± 0.15; 660 Mev, 77°, -0.51 ± 0.17; 755 Mev, 76°, -0.55 ± 0.15; 810 Mev, 89°, -0.45 ± 0.17; 895 Mev, 90°, -0.42 ± 0.16. The recoil protons were momentum-analyzed with a magnetic spectrometer. Nuclear emulsion was used as scatterer and detector. The emulsion technique is discussed in detail. The number of individual scatterings in emulsion used for each measurement varied between 750 and 1000. (auth)

37595 COMPOSITE MODELS AND SU(6) INVARIANCE. Kuo, T. K. (Brookhaven National Lab., Upton, N. Y.); Radicati, L. A. Phys. Rev., 139: B746-50(Aug. 9, 1965). (BNL-9047).

A nonrelativistic model for the baryons and the baryon resonances based on three quarks with fractional charges is discussed. It is shown that it is possible to have the ground state to correspond to the 56-dimensional representation of SU(6) by introducing attractive three-body forces on which are superimposed weaker repulsive two-body forces. The departure from the SU(6)-symmetrical limit is discussed in terms of three types of exchange forces which turn out to be of the same order of magnitude. (auth)

37596 RELATIVISTIC SMALL-ANGLE SCATTERING OF TWO CHARGED PARTICLES. Rolnick, William B.; Thaler, R. M. (Case Inst. of Tech., Cleveland). Phys. Rev. Letters, 15: 117-18(July 19, 1965).

A suggestion concerning small-angle Coulomb scattering of charged particles of equal mass is shown to also apply to the forward scattering of charged particles of different mass. (J.F.P.)

37597 REMARKS ON THE B MESON. Goldhaber, Gerson; Goldhaber, Sulamith; Kadyk, John A.; Shen, Benjamin C. (Univ. of California, Berkeley). Phys. Rev. Letters, 15: 118-22(July 19, 1965). (UCRL-16081)

In order to study the properties of the meson (B) the analysis of $\pi^+ + p \rightarrow \pi^+ + \pi^- + \pi^0 + \pi^+ + p$ interactions is reported. The interactions took place at 3.65 and 3.7 Bev/c for the π^+p and π^-p interactions respectively. While the meson(ω) is not directly observable, it can be inferred from the energy distribution of its decay products, such triplets in other energy ranges being considered background events. A few restrictions were able to be placed on the properties of the meson (B). (J.F.P.)

37598 SEARCH FOR $\eta^0 \rightarrow e^+ + e^- + \pi^0$. Price, LeRoy R.; Crawford, Frank S. Jr. (Univ. of California, Berkeley). Phys. Rev. Letters, 15: 123-5(July 19, 1965). (UCRL-16166).

An experimental search is made for the decay $\eta^0 \rightarrow e^+ + e^- + \pi^0$ to study CP-invariance violation in K_2^0 decay. One good candidate and three poor ones were found from 219 observed decays. However, these four events were also good fits to $\eta^0 \rightarrow \pi^+ + \pi^- + \gamma$. It is therefore assumed that the one good candidate is a real decay of the type investigated in order to obtain an upper limit for $\Gamma(\pi^0 e^+ e^-)$. This upper limit is compatible with C invariance. (J.F.P.)

37599 REACTION $\pi^- + d \rightarrow d + \pi^- + \pi^+ + \pi^-$ AT 3.7 Bev/c AND EVIDENCE FOR A d π^- ENHANCEMENT. Abolins, M. A.; Carmony, D. D.; Lander, R. L.; Xuong, Ng.-h. (Univ. of California, San Diego, La Jolla). Phys. Rev. Letters, 15: 125-8(July 19, 1965).

In order to search for the enhancement of $d\pi^-$, 2800 four-prong events produced by 3.7-Bev/c π^-d collisions were analyzed and 158 identified as the type $\pi^- + d \rightarrow d + \pi^- + \pi^+ + \pi^-$. Of these, 39 are unambiguously identified as deuteron final states from range and curvature measurements. The others can also be interpreted as $\pi^- + d \rightarrow p + n + \pi^- + \pi^- + \pi^+$. Histograms of these data are made and show various properties of these interactions including the restriction of momentum transfer by deuteron survival. There is also a statistically small enhancement of the $d - \pi^+$ effective mass. (J.F.P.)

37600 CHARGED $K_{\pi 2}$ BRANCHING RATIO. Callahan, A.; Cline, D. (Univ. of Wisconsin, Madison). Phys. Rev. Letters, 15: 129-30(July 19, 1955).

A measurement of the $K_{\pi 2}$ ($K^+ \rightarrow \pi^+ + \pi^0$) branching ratio for detection of the shadow meson (π^0) is made with good statistics using π^+ as a detection method. This measurement is completely consistent with the branching deduced from π^0 measurements. It is also pointed out that there is a discrepancy between the $K_{\pi 2}$ rate of mesons (K^+) and mesons (K^-), suggesting a possible CP-invariance violation in this mode. The mesons (K^+) used in this experiment were stopped in a heavy-liquid chamber filled with C_3F_8. The mesons (π^+) were identified by the $\pi^+ \rightarrow \mu^+ \rightarrow e^+$ decay chain. Also the range of the mesons (π^+) was restricted to be consistent with that expected from the $K_{\pi 2}$ decay. (J.F.P.)

37601 QUANTUM NUMBERS OF RELATIVISTIC ROTATIONAL STATES. Corben, H. C. (Thompson Ramo Wooldridge, Inc., Redondo Beach, Calif.). Phys. Rev. Letters, 15: 268-71(Aug. 9, 1965).

The hypothesis that all or part of the elementary-particle spectrum may be simply a system of rotational rest-energy levels is tested by adding to the Dirac or Kemmer irreducible relativistic wave equations an extra term, analogous to the Pauli term, which represents rotational energy in a Lorentz-invariant manner. (C.E.S.)

37602 SU(9) SYMMETRY OF BARYONS AND MESONS. Singh, Virendra (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Letters, 15: 271-4(Aug. 9, 1965).

An SU(9) symmetry model is proposed for baryons and mesons in which the fusion achieved in $G_3(B \otimes SU(6)_{I,Y,J})$ is extended one step further to include the baryon gauge group B. (J.F.P.)

37603 CONNECTIONS BETWEEN THE STATIC BOOTSTRAP THEORY AND THE ALGEBRA OF CURRENT COMPONENTS. Fulco, Jose R. (Univ. of California, Santa Barbara); Wong, David Y. Phys. Rev. Letters, 15: 274-7(Aug. 9, 1965).

It is shown that the coupling-constant ratios obtained through the commutation rules for octet axial-vector currents are in fact the same as the results of the static-bootstrap equations for the scattering of an axial-vector octet by a spin-½ multiplet, in the cases both of the baryon octet as well as of the quark triplet. Although bootstrap equations in the static approximation are no more than a set of self-consistent relations among coupling constants, they offer a bridge to the calculation of relativistic scattering amplitudes when the static approximation is abandoned. It is apparent that a self-consistent solution can be obtained without using full SU(6) multiplets in the external channels, but the virtual particles required by the self-consistency of the bootstrap equations always appear to be full SU(6) multiplets. (J.F.P.)

37604 THE $\bar{p} + p \rightarrow \bar{1} + 1$ REACTION WITH POLARIZED PARTICLES. Bilen'kii, S. M.; Ryndin, R. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 57-9(July 1965).

Translated from Yadern. Fiz., 1: 84-8(Jan. 1965).

Because the electromagnetic form factors of the proton are complex for time-like momentum transfers, their determination requires experiments with polarized particles. An expression for the differential cross section of the annihilation process $\bar{p} + \vec{p} \rightarrow \bar{1} + 1$ with polarized protons and antiprotons is obtained in the one-photon approximation. A method is suggested for the experimental verification of the one-photon approximation, based on the study of the total annihilation cross sections for polarized particles. (auth)

37605 THE DIFFERENTIAL CROSS SECTIONS FOR THE PROCESSES $e^+ e^- \rightarrow \mu^+ \mu^- \nu_e \bar{\nu}_e$ AND $e^+ e^- \rightarrow \mu^+ \mu^- \nu_\mu \bar{\nu}_\mu$. Dolgov, A. D. (Inst. for Theoretical and Experimental Physics, USSR). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 60-1(July 1965).

Translated from Yadern. Fiz., 1: 89-91(Jan. 1965).

The differential cross sections for the processes $e^+ e^- \rightarrow \mu^+ \mu^- \nu_\mu \bar{\nu}_\mu$ and $e^+ e^- \rightarrow \mu^+ \mu^- \nu_e \bar{\nu}_e$ are calculated assuming that they are caused by a weak local interaction. A simple method is proposed for the calculation of the absolute magnitude squared of the matrix elements. (auth)

37606 PHOTOPRODUCTION OF NEUTRAL PIONS NEAR THE THRESHOLD. Baldin, A. M.; Govorkov, B. B.; Denisov, S. P.; Lebedev, A. I. (Lebedev Inst. of Physics, Moscow). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 62-4(July 1965).

Translated from Yadern. Fiz., 1: 92-5(Jan. 1965).

Experimental data on the $\gamma + p \rightarrow p + \pi^0$ interaction in the vicinity of the threshold are analyzed in order to determine the meson (π^0) photoproduction electric dipole amplitude E. Two methods of determining E lead to different values for this quantity. (auth)

37607 DETERMINATION OF THE CONTRIBUTION OF THE (3/2, 3/2) ISOBAR TO THE INELASTIC $\pi^- p$ INTERACTION PROCESSES AT 344 Mev MESON KINETIC ENERGY. Blokhintseva, T. D.; Grebinnik, V. G.; Zhukov, V. A.; Kravtsov, V. A.; Libman, G.; Nemenov, L. L.; Selivanov, G. I.; Yuan, Jung-fang (Joint Inst. for Nuclear Research, Dubna, USSR). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 71-7(July 1965).

Translated from Yadern. Fiz., 1: 103-12(Jan. 1965).

By analyzing the difference of the distributions of the number of interactions $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ with respect to the total center of mass energy for $\pi^- - n$ and $\pi^+ - n$ interactions, the contribution of the (3/2, 3/2) isobar to the cross section of the interaction is determined at an initial meson (π^-) energy of 344 Mev. An analogous analysis is performed for data obtained at 290 and 360 Mev. It is shown that the difference of the cross section is related to the transition $D_{3_3} \rightarrow SP_{3_3}$. The possibility of determining $\pi - \pi$ scattering lengths from an analysis of this transition is indicated. (auth)

37608 QUASIELASTIC $\pi^- n$ INTERACTIONS AT 9 Gev. Gramenitskii, I. M.; Kanarek, T.; Mal'tsev, V. M.; Prokes, A.; Tikhonova, L. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 78-83(July 1965).

Translated from Yadern. Fiz., 1: 113-21(Jan. 1965).

Quasielastic $\pi^- - n$ scattering at 9 Bev/c was studied in a bubble chamber. For scattering angles larger than 2°, the $\pi^- - n$ cross section is 2.31 ± 0.26 mb; the total $\pi^- - n$ elastic cross section is 4.9 ± 0.5 mb. Within the experimental errors, the differential scattering cross section is equal to the $\pi^+ - p$ differential cross section at 8.8 Bev/c. The following optical characteristics of the neutron were determined: the radius $R = 1.08 \times 10^{-13}$ cm, and the absorption coefficient $K = 0.58 \times 10^{13}$ cm^{-1}. On the basis of one case of $\pi^- - n$ scattering into the backward hemisphere in the laboratory system, the $\pi^- - n$ cross section for backward scattering was estimated to be 0.020 mb for scattering through an angle greater than 90°. (auth)

37609 MEASUREMENT OF THE ENERGY DEPENDENCE OF THE ELASTIC pp SCATTERING DIFFERENTIAL CROSS SECTION AT ENERGIES FROM 3 TO 9.5 Bev. Kanavets, V. P.; Levintov, I. I.; Morozov, B. V.; Nikiforov, N. A. (Inst. of Theoretical and Experimental Physics, USSR). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 90-2(July 1965).

Translated from Yadern. Fiz., 1: 130-3(Jan. 1965).

The results are presented of relative measurements of the differential cross section for p-p elastic scattering in the energy range from 3 to 9.5 Bev for fixed values of the square of momentum transfer equal to 0.108, 0.178, 0.258, and 0.337 (Bev/c)^2. The measurements were made in the internal beam of the accelerator; the proton beam was monitored by means of a miniature ionization chamber. An appreciable shrinkage of the diffraction cone is observed between 3 and 6 Bev. (auth)

37610 TOTAL CROSS SECTIONS FOR INTERACTION OF NEUTRONS WITH PROTONS AND NEUTRONS FROM 2.6 TO 8.3 Bev. Pantuev, V. S.; Khachaturyan, M. N.; Chuvilo, I. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 93-9(July 1965).

Translated from Yadern. Fiz., 1: 134-44(Jan. 1965).

The total cross sections for interactions of neutrons having mean effective energies of 2.6, 3.9, 5.5, 6.9, and 8.3 Bev with neutrons and protons were measured under conditions of good geometry. (D.C.W.)

37611 ANGULAR DEPENDENCE OF TRANSVERSE PION MOMENTUM. Boos, E. G.; Vinitskii, A. Kh.; Takibaev, Zh. S. (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 102-4(July 1965).

Translated from Yadern. Fiz., 1: 148-51(Jan. 1965).

The transverse momentum distribution of 1536 mesons (π) is investigated as a function of their emission angle; the mesons (π) were produced in $\pi - N$ interactions at 7.5 Bev. The angular dependence of the transverse momentum can be accounted for by energy and momentum conservation. Conditions are considered under which the assumption of a constant transverse momentum can be used to determine the kinematic properties of the secondary particles. (auth)

37612 UNITARY DESCRIPTION OF REACTIONS WITH FORMATION OF SEVERAL NONRELATIVISTIC PARTICLES. Gorelik, R. B.; Klepikov, N. P.; Yudin, V. A. (Moscow State Univ.). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 105-10(July 1965).

Translated from Yadern. Fiz., 1: 152-9(Jan. 1965).

Nonrelativistic wave functions of N free particles are given in coordinate representation for states having defi-

nite values of conventional and generalized angular momenta. The reaction amplitudes for transitions of two particles into N particles are expressed in terms of the elements of the unitary S-matrix in the angular momentum representation. (auth)

37613 THE $\Delta T = 1/2$ RULE FOR HADRON DECAY. Kobzarev, I. Yu.; Okun, L. B. Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 111-12(July 1965).

Translated from Yadern. Fiz., 1: 160-2(Jan. 1965).

Possible experiments are discussed by which the origin of the $\Delta T = 1/2$ rule could be established. One of these experiments is a measurement of the admixture of transitions with $\Delta T = 5/2$ in τ decays. Another experiment is a test of isotopic relations in single production of strange particles. (auth)

37614 NUCLEON-DEUTERON INELASTIC SCATTERING AT LOW AND MEDIUM ENERGIES. Popova, A. M.; Shtefan, Muskalu (Moscow State Univ.). Yadern. Fiz., 1: 776-84(May 1965). (In Russian)

Expressions for the differential cross sections of the $n + d \rightarrow 2n + p$ and $p + d \rightarrow 2p + n$ interactions were obtained by summing the nonrelativistic diagrams corresponding to N-d inelastic scattering. The scattering amplitude was represented as the sum of an impulse-approximation amplitude and the Glauber correction. The theoretical energy and space distributions for the $n + d \rightarrow 2p + n$ interaction at 14 Mev and the $p-d \rightarrow 2p + n$ interaction at 158 Mev were compared with experimental observations. (D.C.W.)

37615 ON THE CALCULATION OF NUCLEON-NUCLEON POTENTIAL SCATTERING PARAMETERS AT LOW ENERGIES. Babikov, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 793-802(May 1965). (In Russian)

Simple methods are suggested for the calculation of low-energy nucleon-nucleon scattering parameters. The Coulomb potential is taken into account exactly in the case of $^1S_0$ p-p scattering. The influence of tensor forces in $^3S_1$ n-p scattering is also considered. Using these methods, scattering lengths, effective ranges and shape parameters are calculated for several N-N potentials with both hard and soft repulsive cores. (auth)

37616 FORM OF THE MOMENTUM SPECTRUM IN PARTICLE SCATTERING. Tolstov, K. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 832-4(May 1965). (In Russian)

It is shown that in the inelastic and elastic scattering of fast particles the proton spectrum with respect to the cartesian axes is well approximated by a Gaussian distribution. The ratio of the longitudinal and transverse momentum dispersion is in agreement with the uncertainty principle and the Lorentz contraction of the interaction region in the longitudinal direction. (auth)

37617 ANALYSIS OF THE METHODICAL ERRORS IN THE STUDY OF NUCLEAR INTERACTIONS BY THE PHOTOEMULSION METHOD. Murzin, V. S. (Moscow State Univ.). Yadern. Fiz., 1: 835-41(May 1965). (In Russian)

The influence is studied of the spectrum of nuclear-active particles and of the method of choosing events on the characteristics of the elementary act in investigations using photoemulsions. It is shown that if the Castagnoli method is used to determine the energy of the generating particles, the errors due to inaccurate energy measurements in individual cases can distort the elementary act characteristics many times. Threshold effects appear up to energies 1000 times higher than the threshold. This leads to an apparent decrease of the inelasticity coefficient with the energy, to the constancy of the average multiplicity in the high-energy region, and to other effects. (auth)

37618 COHERENT RADIATION FROM COSMIC-RAY μ MESONS WITH THE ENERGIES 700 TO 6000 Gev IN LAMINAR MEDIUM. Arutyunyan, F. R.; Ispiryan, K. A.; Oganesyan, A. G. Yadern. Fiz., 1: 842-9(May 1965). (In Russian)

Experimental results are given on transient interference radiation originating when 700 to 6000-Bev mesons (μ) pass through a periodical laminar medium. The horizontal meson(μ) spectrum at a height of 1000 m above sea level was determined in this energy region from the measured radiation intensity. (auth)

37619 SUGGESTED EXPERIMENTS IN LOW-ENERGY ANTINEUTRINO PHYSICS. Mikaelyan, L. A.; Spivak, P. E.; Tsinoev, V. G. Yadern. Fiz., 1: 853-5(May 1965). (In Russian)

A number of experiments are discussed concerning low-energy interactions of antineutrinos. The program includes experiments on $\bar{\nu}_e - e$ scattering, on the electromagnetic properties of the antineutrino, and investigations of inverse β-decay on the proton and on other nuclei. (auth)

37620 ENERGY SPECTRA OF LONGITUDINALLY POLARIZED RECOIL ELECTRONS IN NEUTRINO (ANTINEUTRINO)-ELECTRON SCATTERING. Kerimov, B. K.; Romanov, Yu. I. (Inst. of Medical Radiobiology, Academy of Medical Sciences, USSR). Yadern. Fiz., 1: 856-9(May 1965). (In Russian)

The energy distributions of recoil electrons in neutrino (antineutrino)-electron scattering were obtained in the lowest, with respect to the mixed (V, A) weak interaction, perturbation theory approximation. It is shown that the longitudinal polarization of the recoil electron significantly influences the energy distribution. (auth)

37621 INTERMEDIATE MESON CREATION BY COLLIDING BEAMS. Dolgov, A. D.; Solov'ev, V. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 1: 860-6(May 1965). (In Russian)

The semi-weak interactions of mesons(W) with leptons in the process $e^+ + e^- \rightarrow W^+ + W^-$ are considered. It is shown that an investigation of the angular distribution asymmetry with respect to the direction of the electron beam, both for mesons(W) and for charged leptons from the decay $W^\pm \rightarrow l^\pm + \nu(\bar{\nu})$, makes it possible to study the form factor of this interaction. Angular distribution graphs and estimations of the asymmetry are given. It is shown that under certain conditions, the asymmetry may be as great as several percent and can thus be observed experimentally. (auth)

37622 A FURTHER INVESTIGATION OF p-p SCATTERING PHASE SHIFTS AT 435 Mev. Azhgirei, L. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 867-9(May 1965). (In Russian)

A set of phase shifts that was previously obtained for proton-proton scattering at 435 Mev was improved by taking into account new data on triple scattering parameters. (D.C.W.)

37623 DETECTION OF A RESONANCE IN THE $K^0\bar{K}^0$ SYSTEM AT 1280 Mev. Barmin, V. V.; Dolgolenko, A. G.; Erofeev, I. A.; Krestnikov, Yu. S.; Meshkovskii, A. G.; Tikhomirov, G. D.; Trebukhovskii, Yu. V.; Shevanob, V. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 1: 870-5(May 1965). (In Russian)

The effective distribution of 159 $K^0\bar{K}^0$ pair events generated by mesons(π^-) with a momentum 2.8 Bev/c on H, C and Xe nuclei was investigated. The result is the same as that obtained by Barmin in 1962. A peak with a mass of 1280 Mev and a width ~80 Mev appears in the effective mass distribution. This peak cannot be explained by reactions with meson(π) formation or by resonances in the K-N or K-π systems. The hypothesis is discussed that the 1280-Mev peak may be due to the decays $f \rightarrow K_1^0 + K_1^0$ and $A_2^0 \rightarrow K_1^0 + K_1^0$ or to one of them. The value $w(f \rightarrow K_1^0 + K_1^0)/w(f \rightarrow \pi^+ + \pi^-) \leq 2.3 \pm 1.0\%$ is obtained. (auth)

37624 NUCLEON CHARGE EXCHANGE IN INELASTIC N-N INTERACTIONS AT VERY HIGH ENERGIES. Kuchin, I. A.; Sanko, L. A.; Usik, P. A. (Inst. of Nuclear Physics, Kazkh SSR). Yadern. Fiz., 1: 876-8 (May 1965). (In Russian)

Experimental data on the charge exchange of the target nucleon in N-N collisions at very high energies are used to estimate the relative contribution of processes in which nucleons are excited to isobar states. (auth)

37625 CROSS-SECTION ASYMPTOTICS AND POTENTIAL SCATTERING. Khriplovich, I. B. Yadern. Fiz., 1: 912-21(May 1965). (In Russian).

Scattering on energy-dependent exponential-type potentials is considered. The character of this dependence, leading to the asymptotic growth of the total cross sections is found. The maximal increase of the potential with the energy, compatible with the usual analytical properties of the scattering amplitude, is found. A similar limit on the increase of the potential is obtained by requiring the usual interpretation of the wave function. An example is given of a scattering amplitude which leads to a total cross section that increases as the squared logarithm of the energy. (auth)

37626 ON THE ROLE OF THE GROUP O_4 LOCAL COMPLEX ORTHOGONAL TRANSFORMATIONS IN A NONLINEAR THEORY OF ELEMENTARY PARTICLES. Braunss, G. (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch., 20a: 649-55(May 1965).

It is supposed that there exists a system O′ (intrinsic system) in which the field equation for a spin ½ representation has the simple form $\gamma_\mu \partial\psi'/\partial x_\mu' = 0$. This system is related to the physical system (in which all measurements are performed) by an affine connection which is induced by a certain group of local transformations. The investigation deals with the group of local four-dimensional complex orthogonal transformations. (L.B.S.)

37627 METHODS AND RESULTS OF A GENERAL THEORY OF PARTICLES WITH SPIN AND ITS CONNECTION WITH SU_{12}. Castell, L. (Trinity Coll., Dublin). Z. Naturforsch., 20a: 737-8(May 1965).

The results of previous attempts to combine the charge symmetrics of elementary particles with space-time structure are reviewed and presented in a new form; and the connections with the Bargmann-Wigner equation along with some later developments in the theory of field equations for particles with arbitrary spin are pointed out. (L.B.S.)

37628 S-AMPLITUDES OF HADRON DECAYS OF BARYONS AND SU(6) SYMMETRY. Matinyan, S. G. (Inst. of Physics, Academy of Sciences, Georgian SSR). Zh. Eksperim. i Teor. Fiz., 48: 1204-6(Apr. 1965). (In Russian)

The s-wave amplitudes of hadronic decays of baryons in the SU(6) symmetry scheme. Unitary relations are written out for the spurion associated with the hadron weak interaction Lagrangian. It is shown that the s-wave amplitude of the $\Sigma^+ \to n\pi^+$ decay is zero. This explains theoretically for the first time the well-known experimental fact that there is no asymmetry in the decay $\Sigma^+ \to n\pi^+$ and $\Sigma^- \to n\pi^-$. Relations are then derived between the s-amplitudes of all the hadronic decays of baryons ($B \to B + M$). These relations satisfy the triangle relations between the amplitudes of Λ, Ξ, and Σ decays, obtained in several other papers and agreeing with experiment. Whether these relations are in full accord with experimental data will become clear only after the measurements of the parameters of hadronic decays of hyperons become more accurate. (ATD)

37629 MUON POLARIZATION AND THE FORM FACTOR RATIO IN $K^+_{\mu 3}$-DECAY. Waisenberg, A. O.; Smirnitskii, V. A. Zh. Eksperim. i Teor. Fiz., 48: 1604-10 (June 1965). (In Russian)

The positron angular distribution for 887 mesons (μ^+) produced in $K^+_{\mu 3}$ decay and the magnitude of the meson (μ^+) longitudinal polarization, $P_\mu = +0.68 \pm 0.28$ were measured in an emulsion chamber. The result obtained seems to indicate a form factor ratio $\xi = 0 \pm 1$. (auth)

37630 RADIATION EMISSION IN TWO-PARTICLE ELECTRON-POSITRON ANNIHILATION. Baier, V. N.; Khoze, V. A. (Novosibirsk State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 48: 1708-16(June 1965). (In Russian)

The integral cross section for photon emission in electron-positron pair annihilation into a pair of scalar particles is calculated by a method previously proposed by the authors. An analysis of the photon emission cross section for annihilation of an electron-positron pair into a pair of any two particles is carried out by taking into account the form factors. The cross section for emission by electrons is calculated exactly, whereas the emission cross section by final particles is expressed through the first two terms of the expansion in powers of ω/E. For evaluation of the second expansion term, the Low method is employed. The interference term vanishes in all cross sections considered. (auth)

37631 CONSERVATION OF VECTOR CURRENT AND THE $\nu + N \to \mu + N + \pi$ PROCESS. Shabalin, E. P. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 1750-8(June 1965). (In Russian).

The relation between the $\nu + N \to \mu + N + \pi$ process and electroproduction of mesons (π) is established phenomenologically on basis of the hypothesis of conservation of vector current. Numerical values are obtained by employing the experimental data on electroproduction of mesons (π). (auth)

37632 THREE-PARTICLE UNITARITY CONDITIONS FOR COMPLEX ANGULAR MOMENTA AND THE MANDELSTAM BRANCHING POINTS. Azimov, Ya. I.; Anselm, A. A.; Gribov, V. N.; Danilov, G. S.; Dyatlov, I. T. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 48: 1776-86(June 1965). (In Russian)

The contribution of three-particle states to the unitarity condition for the elastic partial-wave amplitude is studied. The unitarity condition is extended to complex values of the angular momentum j in such a way that no amplitude singularities arise for large values of Rej. It is found that the three-particle contribution should contain a sum of not only integer but also of complex values of the angular momentum projection (m). This results in the appearance of Mandelstam branching points in the j-plane. In conclusion, the possibility of writing down the unitarity condition in the form of a contour integral with respect to m is discussed. (auth)

37633 AN UNSCRAMBLING TECHNIQUE FOR SPECTRUM ANALYSIS AND ITS APPLICATION TO COMPLEX γ-RAY SPECTRA. Yates, M. J. L. (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). pp 533-9 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A new method for spectrum analysis is described which overcomes the difficulties of oscillations in the solution by minimizing a function depending both upon the goodness of fit and upon the smoothness of the solution, using a direct search for the minimum of this function. Advantages of the method are that it is fast, it is nonsubjective and produces only non-negative solutions. Known approximations to the solution can be used as the starting point of the search, and it can deal with both discrete and continuous spectra. Applications to complex γ-ray spectra are described. (auth)

37634 I. THE SCANNING AND MEASURING PROJECTOR. II. K^-p ELASTIC SCATTERING AT 1.22 Bev/c. Munson, John Herbert. Thesis, Berkeley, Calif., Univ. of California, 1964. 84p.

The Scanning and Measuring Projector (SMP) is a semi-automatic device for making rapid and accurate measurements on bubble chamber or other photographs. The SMP, its human operator, and a general-purpose digital computer work together in an integrated system. The SMP digitizing mechanism and process and the configuration of the over-all system are described. Also discussed are the pattern-recognition and time-sharing aspects of the associated computer program, and its error-correcting capabilities. The history and performance of the SMP and plans for extending the scope of the SMP system are outlined. Three thousand K^-p elastic scattering events at 1.22 Bev/c were studied. These events are part of a sample of 7000 events of the two-prong topology, produced in the Lawrence Radiation Laboratory 72-inch hydrogen bubble chamber. Fitting of the corrected elastic-scattering center-of-mass angular distribution suggests that terms to $\cos^6 \theta$ are

needed, although a fit to $\cos^5\theta$ is certainly not excluded. The elastic-scattering data, together with the published charge-exchange data from the same exposure and data at 1.34 Bev/c, are subjected to a partial-wave analysis, parameterized in terms of $\bar{K}p$ resonances at 1765, 1815, and 2100 Mev. The Y_1^* (2100) parameterization, with width 180 Mev and elasticity 0.35, is suggested by the $\bar{K}p$ and $\bar{K}n$ total cross-section curves. The predicted angular distributions are in good agreement with the experimental distributions. Dalitz plots are presented for the partially analyzed three-body reactions appearing in the two-prong topology and obtained as a by-product. (Dissertation Abstr.)

37635 THE ANOMALOUS MAGNETIC MOMENT OF THE ELECTRON. Mann, Ronald Arlett. Thesis, Cincinnati, Univ. of Cincinnati, 1964. 33p.

The Schwebel-Sachs self-consistent field theory of quantum electrodynamics is used to calculate the anomalous magnetic moment of the electron without recourse to renormalization and perturbation techniques. It was shown by the originators of the theory that their basic postulate, that the interactions between particles and not the particles themselves are the physical observables, led to an elimination of the self-interactions that plagued even classical theory and to a new electromagnetic force, the dual Lorentz force. It is shown in this paper that this dual Lorentz force gives rise to an additional magnetic interaction, which may be interpreted as the anomalous magnetic moment. With this interpretation it is shown that for a free electron in a uniform magnetic field the anomaly (A) is given by $A = 2$ mcg/ħ where g is the coupling constant of the field-current interaction that represents the dual Lorentz force and has the dimensions of length. Using the value of g obtained from the successful calculation of the value of the Lamb shift in the original paper, it is shown that $A = 1.087 \times 10^{-3}$. The small discrepancy between this value and that of Schupp, Pidd, and Crane's free relativistic electron measurement is attributed to the approximations that were made in the Lamb shift calculations. Recalculation of g on the basis of the experimental value of the anomaly leads to $g = 2.24 \times 10^{-14}$ cm instead of the 2.087×10^{-14} obtained by Lamb shift. It is shown that the theory can be successfully applied to the proton anomaly yielding $A = 1.99$ compared to the magnetic resonance value of 1.87. Failure of the theory to yield the muon anomaly is attributed to the muon's structure. (Dissertation Abstr.)

37636 THE PAIR DISTRIBUTION FUNCTION IN QUANTUM STATISTICAL MECHANICS. Yee, Daniel Doo Hon. Thesis, Brooklyn, Polytechnic Inst., 1964. 49p.

Recently Lee and Yang presented in a series of papers a general method for the determination of the partition function of a many-body system obeying quantum statistical mechanics. This method is extended to determining the pair distribution function in quantum statistical mechanics. A general cluster expansion of the pair distribution function in coordinate and momentum space is given. This method is then applied to the calculation of the pair distribution function for a dilute system of hard sphere Boltzmann gas at finite temperatures and to a hard sphere Bose gas at zero temperature. The ground state energy and the phonon spectrum of a hard sphere Bose gas are calculated, and the results are compared with those obtained by other authors. It is found that the important contribution to the ground state energy comes from the so-called chain diagrams. However, the summation over the chain diagrams leads to a divergent result for the ground state energy. An additional set of diagrams is summed for the removal of this divergence. The contribution from these additional diagrams affects only the short range behavior of the pair distribution function, while the chain diagrams play a major role at large distances. Interpretations and conclusions are compared with those of other authors. (A.G.W.)

37637 PION-PROTON INTERACTIONS AT 780 Mev. Tilger, Clarence Arthur Jr. Thesis, Bloomington, Ind., Indiana Univ., 1964. 83p.

The interactions of protons with pions having a laboratory kinetic energy of 780 Mev are examined. Using the optical theorem and the value of the total cross section determined in previous work by Devlin et al., the elastic angular distribution is $(0.24 \pm 0.03) + (0.82 \pm 0.09)\cos\vartheta + (2.40 \pm 0.22)\cos^2\vartheta + (0.37 \pm 0.15)\cos^3\vartheta - (1.45 \pm 0.26)\cos^4\vartheta$ where the coefficients are in mb/sterad. The elastic cross section is 10.1 ± 1.4 mb and the one-pion production cross section is 12.2 ± 1.4 mb. The ratio of the cross section for neutral pion production to charged pion production is $4.35 \pm 0.30 : 1$. The kinetic energy and angular distributions of the particles in the one-pion production final states are examined and compared with the predictions of various models. In particular, the $D_{3,3}$ isobar model and the vector meson exchange model are examined. While both of these fit the data in part, neither agrees with the whole of the data and further theoretical analysis is necessary to fully explain the one pion production process. (Dissertation Abstr.)

37638 ELASTIC SCATTERING AMPLITUDES: THREE APPROACHES. Swift, Arthur Reynders. Thesis, Philadelphia, Univ. of Pennsylvania, 1964. 193p.

Three approaches to the theoretical description of elastic scattering amplitudes are discussed. In part I a model of fermion-antifermion scattering, mediated by pseudoscaler neutral bosons, is described by the corresponding spinorial Bethe-Salpeter equation in the ladder approximation. The decomposition of the equation into partial waves by means of fusion amplitudes and conventional spherical harmonics is discussed in detail. The resulting set of coupled equations is continued into the complex angular momentum (J) plane. The equations are solved in a weak coupling, low-energy limit by an iterative scheme that decouples the amplitudes in a consistent fashion. In part II the scalar Bethe-Salpeter equation for scattering is investigated in configuration space for the class of singular potentials that behaves as r^{-4} near the light cone. The differential form of the Bethe-Salpeter equation is expanded in four dimensional spherical harmonics, and the singular part of the potential is incorporated into the differential operator. The resulting equation is formally solved by converting it into what is now a Fredholm integral equation. The exact scattering amplitude is found for exchange of two massless mesons. A first order solution is obtained for a phenomenological potential that approximates the exchange of two massive mesons. In part III the dispersion relations of Fivel are extended to physically meaningful situations. On the basis of the Mandelstam representation and a modified form of the partial wave expansion a closed system of equations is obtained for the partial wave amplitude for values of the angular momentum defined by real l equal to a positive constant. A solution by iteration is indicated. The methods of this part are extended to provide a new derivation of the integral equation satisfied by the Mandelstam spectral function. The formalism is extended to a simple relativistic model corresponding to a $\lambda\varphi^4$ field theory. (A.G.W.)

37639 ARE LOW ENERGY SCATTERING DATA CONSISTENT WITH CHARGE INDEPENDENCE? Schneider, Ronald E. Thesis, Cleveland, Case Inst. of Tech., 1964. 57p.

The specifically nuclear force operating between two nucleons has been assumed to be independent of the charges of the interacting particles. The low-energy scattering data do not quantitatively support this assumption for the singlet S-state nucleon-nucleon interaction that is investigated here. Two effects at least partially responsible for the deviations from absolute charge independence are the electromagnetic interaction between the nucleons considered as extended structures and the difference in the one-pion exchange contribution to the nuclear potential, which arises because the masses of the exchanged pions are somewhat different in the two cases. These effects are explicitly computed assuming the nuclear potential to be that of Yukawa with a hard core. It is found that both effects are such as to support the charge independence hypothesis but

they do not fully account for the observed differences in proton-proton and neutron-proton low energy singlet scattering. (Dissertation Abstr.)

37640 VOPROSY FIZIKI ELEMENTARNYKH CHASTITS. Chetvertaya Sessiya Vessenei Shkoly Teoreticheskoi i Eksperimental'noi Fiziki Nor-Amberd, 16-26 Aprelya 1964 g. (Problems in Physics of Elementary Particles. The Fourth Session of the Spring School of Theoretical and Experimental Physics, Nor-Ambert, April 16-26, 1964). Alikanyan, A. I. (ed.). Erevan, Publishing House of Academy of Sciences, 1964. 600p.

Thirty-six lecture papers and one scientific communication are included. Separate abstracts were prepared for all 37 papers. (CFSTI)

For abstracts of individual papers see: 36857, 36858, 36859, 36860, 37238, 37415, 37641, 37642, 37643, 37644, 37645, 37646, 37647, 37648, 37649, 37650, 37651, 37652, 37653, 37654, 37655, 37656, 37657, 37658, 37659, 37660, 37661, 37662, 37663, 37664, 37665, 37666, 37667, 37668, 37700, 37701, and 37903.

37641 NEW DATA ON BARYON ISOBARS. Chuvilo, I. V. pp 9-23 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

A survey is given of Western investigations of the Y_1^* 1660-Mev resonance, the Ξ^* 1530-Mev hyperon, and the $Y_1^{*-} - Y_1^{*+}$ isobar mass difference. A table is included covering all known baryon resonances. (CFSTI)

37642 RESONANCES IN π-MESON SYSTEMS (NEW DATA). Grishin, V. G. pp 24-44 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian).

New data from world scientific references are surveyed. Extended coverage is given to the meson (ρ); possibility of an $M \approx M(\rho^0)$, $I = 0$ resonance; meson (ω); ρ -ω transition; meson (η); meson (f); multipion resonance systems; and meson (B). It seems that all the papers reviewed miss the fact that the phase space requirements for 1^- and 2^+ are identical and whatever argument is given in favor of 1^- should be extended to 2^+ as well. (CFSTI)

37643 OBSERVATION OF HYPERONS WITH S = −3 STRANGENESS. Alikhanyan, A. I. pp 45-9 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian).

The discovery of the production and decay of the negatively charged hyperon at the Brookhaven synchrotron is reviewed. (CFSTI)

37644 STRONG INTERACTION IN THE $K\bar{K}$ SYSTEM. Trebukhovskii, Yu. V. pp 50-66 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

A brief description of the known peculiarities of the meson (K) decay is followed by a survey of the current status of the phi resonance, the broad 0^{++}, 1020-Mev resonance near threshold, the ~1410-Mev resonant state, the possible $K\bar{K}$ 1280-Mev resonance, and the K^+K^+ interaction in the 1200 to 1300 Mev region. (CFSTI)

37645 SEARCH FOR A RESONANCE IN THE $(\pi^+\pi^+\pi^-\pi^-)$ SYSTEM DURING THE $\pi^- + p \rightarrow 2\pi^+ + 2\pi^- + n + k\pi^0$ REACTION AT 3.5 Bev/c. Ainutdinov, M. S. pp 67-76 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

A liquid hydrogen bubble chamber was exposed to 3.5-Bev/c mesons (π^-). The analysis of stereophotographs indicates that there exists an ~1250-Mev peak in the $2\pi^+ + 2\pi^-$ systems; such a peak is missing in reactions without meson (π^0) production; the 1250-Mev resonance is accompanied basically by the production of the $(3/2, 3/2)$ 1238-Mev isobar; the half-width of the new resonance is 75 ± 25 Mev, determined mostly by the mean accuracy of the pion masses ~ 75 to 80 Mev; the production cross section is of the order of 0.5 mbarn; and the maximum seems to be related to meson (B^0) production. The isospin I = 1 is ruled out in view of the second point; the strong 1240-Mev peak in the cases of (*) peaks of the $M_{4\pi}$ spectrum supports I = 2. Possible modes of the meson (B) two-particle and four-particle decays are discussed. (CFSTI)

37646 CURRENT STATE OF THE UNITARY SYMMETRY HYPOTHESIS. Shekhter, V. M. pp 79-101 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

The status of the hypothesis as of August, 1964, is surveyed. In particular, the strangeness degeneracy of strong interactions, groups and multiplets, applications to mesons, experimental data on baryons and isobars, checks of the quantitative formulas of unitary symmetry, quarks, and the superunitary strong interaction symmetry ($SU_3 \times SU_3$) are discussed. Tables of all the known elementary particles, meson resonances, and baryon resonances are included. (CFSTI)

37647 UNITARY MULTIPLETS AND MASS FORMULAS. Kobzarev, I. Yu. pp 102-16 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

A brief list of existing iso-multiplets sets the stage for this pedagogical article which covers the general properties of the group, rank of groups and of the conserved quantum number, choice of groups, SU_3 representations, unitary symmetry model, U-spin and V-spin, graphical representation of unitary symmetry, mass formulas, and mass differences of electromagnetic origin. (CFSTI)

37648 SPHERICAL FUNCTIONS OF THE THREE-DIMENSIONAL UNITARY GROUP AND THE CLASSIFICATION OF SUPERMULTIPLETS. Sudakov, V. V. pp 117-24 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

In the case of the three-dimensional unitary group U_3, due to the complexity of its operator algebra, it is quite difficult to establish a group representation using the abstract operator approach. The square of the angular momentum eigenvalue equation in three-dimensional coordinates (angular part of the Laplacian) is, therefore, recast in a form suitable for direct generalization to the U_3 group. Since the U_3 group is singly connected, this approach yields all the representations. A procedure for establishment of the isospin-strangeness diagrams is also given. (CFSTI)

37649 LOGARITHMIC SINGULARITIES IN THREE-PARTICLE PRODUCTION PROCESSES. Anisovich, V. V. pp 125-33 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

Problems connected with the determination of resonances in unstable particle systems are discussed. Special attention is paid to logarithmic resonances which may distort the particle spectra and even imitate resonances. The theory is illustrated by examples of pπ (A), ωπ (B), and Σπ (Λ_{1405} or Y_0^*) resonances. (CFSTI)

37650 MODELING OF RESONANCE PRODUCTION. Kopylov, G. I. pp 134-54 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

The modeling of elementary particle transformations of known amplitudes is discussed with consideration of the specification of the states of particle systems the almost uniform Dalitz plot, the practical realization of the programs, cascades, accidental star tables, and Feynman diagram calculations. A list of six unsolved modeling (programming) tasks is included. (CFSTI)

37651 THE DETERMINATION OF MULTIPION RESONANCE QUANTUM NUMBERS. Kopylov, G. I. pp 155-64 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

The methods for the spin (j) and parity (P) determinations of the as yet unconfirmed four-pion resonances are discussed. Although there still does not exist a strong interaction theory, one can determine the forbidden configu-

ration in a multipion system with given values of j and P which are absolute—they do not depend on the type of strong interactions. As a matter of fact, the j and P determination is possible even in absence of any clear representation of the four- (or more than four) pion states. The discussion covers the general form of the disintegration matrix element, the forbidden configurations, and the cascade decay of resonances. (CFSTI)

37652 MOVING BRANCHING POINTS IN THE j-PLANE AND REGGE UNITARITY CONDITIONS. Gribov, V. N.; Pomeranchuk, I. Ya.; Ter-Martirosyan, K. A. pp 167-206 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

The moving branching point within the angular momentum j-plane is studied by analysis of the multiparticle terms of the unitarity condition in the t-channel. Definite assumptions about analytical continuations of these terms into the complex portions of the plane are used, and branching points of the partial amplitude, $f_j(t)$, appear in the j-plane corresponding to the production thresholds of two or more reggeons with relative orbital angular momentum equal to -1. In the case of two spinless particles in an intermediate state, the partial wave has singularities for negative integral values of the orbital momentum. Azimov found that such singularities move to the right if the particle in the intermediate state has a spin different from zero. The branching points in the j-plane appear as a result of the propagation of this displacement to the entire Regge trajectory. Such mechanism was noted by Mandelstam in certain Feynman diagrams. The presence of such branching points $j = j_n(t)$ where $j_n(t) = n\alpha(t/n^2) - n + 1$ alters essentially the analytical properties of $f_j(t)$ in the t-plane and generates in it branching points at $t = t_n(j)$, where $t_n(j)$ is the solution of the equation $j = j_n(t)$. A calculation of the magnitude of the discontinuity $\delta_j^{(n)} f_j(t) = -\delta_j^{(n)} f_j(t) \simeq \pi \cdot B_n(j_n - j)^{2n-3}$ of $f_j(t)$ at the discontinuity $t = t_n(j)$ corresponding to the production-threshold on n-reggeons (Regge unitarity conditions) is presented, and the characteristics of these discontinuities are discussed. Topics covered in detail are multiparticle terms of the unitarity conditions, difficulties encountered during the analytical continuation into the j-plane, analytical continuation of the three-particle unitarity condition, analytical continuation of the four-particle terms of the unitarity condition, unitarity condition at the two-reggeon singularity, and three-reggeon and multi-reggeon states. A two-page note added in proof states, however, that the $\delta_j^{(n)} f_j(t)$ values for $j \to j_n(t)$ calculated above are incorrect since during their evaluation on the basis of the Regge unitarity condition care was not taken of the threshold properties of the reggeon production amplitudes N_j; n. The corrected approach yields $\delta_j^{(n)} f_j(t) \simeq \pi \cdot B_n(j - j_n)^{n-2}$. (CFSTI)

37653 COMPLEX MOMENTA AND MULTIPLE PRODUCTION. Ter-Martirosyan, K. A. pp 207-20 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

In view of the changes in the understanding of the j-plane structure (j = angular momentum) which occurred during 1963-64 (Regge pole generation of branching points corresponding to several reggeons), it became interesting to find out which of the statements of the theory of complex momenta relative to inelastic processes are still valid and which of them are susceptible to direct experimental confirmation. As far as the "almost elastic" collisions are concerned: all shower particles have moderate transverse momenta, and for large collision energies the momentum distribution is independent of energy; the magnitude of the vector sum of all the transverse momenta of the shower particles should decrease with an increase in the logarithm of the energy; and the system of shower particles must have such quantum numbers that the charge, parity, strangeness, and conservation laws allow the formation of such a system during the absorption of the vacuum reggeon by the incident particle. If this condition is not satisfied, the production cross section of such a system "dies down" with an increase in primary energy. Experiments should decide whether showers consisting of two or several groups of particles with almost equal momenta occur with noticeable probability; which of the two mass-energy-transverse momentum relations $[(s_{12} \cdot s_{23}) = (m_1^2 + \kappa_1^2) \cdot s$ or $s_{12} \cdot s_{23} \cdot s_{34} = (m_1^2 + \kappa_1^2)(m_4^2 + \kappa_4^2) \cdot s]$ appears in nature; in the case of small κ_i^2 which of the two differential cross sections for the "true inelastic" cross sections is correct, either [proportional to $|\rho_0(\xi_1\tau_1)|^2\ |\rho_0(\xi_2\tau_2)|^2$ or $|\rho_0(\xi_1\tau_1)^2|\ |\rho_0(\xi_2\tau_2)|^2\ |\rho_0(\xi_3\tau_3)|^2$ [$\xi_1 = \ln(s_{12}/s_0)$ etc., $\tau_1 = \alpha_0'\kappa_1^2$, $\tau_2 = \alpha_0'\kappa_2^2 = \alpha_0'(\vec{\kappa}_2 + \vec{\kappa}_1)^2$, etc.]; whether the total number of particles produced increases logarithmically with s; and whether the reggeons involved in the collision are of vacuum type. (CFSTI)

37654 COMPLEX MOMENTA AND PARTICLE INTERACTIONS AT HIGH ENERGIES. Gribov, V. N. pp 221-8 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

The theoretical situation is described following the extensive changes in outlook which occurred during the past year. Examples are given of the universal character of the theory. Singularities are discussed in the wake of Mandelstam's discovery that in the relativistic theory, partial waves may have not only poles but also branching points; and attention is focussed on the consequences of this discovery for elastic and inelastic scattering processes. The question remains open concerning other possible branching points. (CFSTI)

37655 ELASTIC SCATTERING AT HIGH ENERGIES (EXPERIMENTAL DATA REVIEW). Lyubimov, A. L. pp 229-46 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

Recent experiments are described which were not covered by the review made a year ago. These are pp and π^-p experiments by Foley and Lindenbaum; the repetition of the pp, π^+p, and π^-p experiments at CERN; forward differential pp cross section experiments; and large-angle pp scattering measurements. Data are compared with the predictions of the Pomeranchuk asymptotic theorem. (CFSTI)

37656 SOME POSSIBILITIES OF COSMIC RAY PARTICLE INTERACTION STUDIES AT HIGH AND ULTRA HIGH ENERGIES (10^{11}-10^{13} ev). Grigorov, N. L. pp 247-57 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

Preliminary experimental data concerning interactions of primary particles with energies between 5×10^{12} and 10^{13} ev are given and discussed as an example of the possible use of cosmic rays for accurate and quantitative study of high and ultra high energy interactions. This field of quantitative research was actually opened up by the discovery of the ionization calorimeters, one of which is already in operation at the Aragats mountain observatory. It is currently used for studies of particles above 5×10^{11} ev whose counting rate is above 50 particles per day. Another approach was taken during studies of π^0 energy spectra in the $E_{\pi^0} \geq 5 \times 10^{10}$ ev region. These particles generated by primary 10^{12}–10^{13} ev particles are registered following the method of controlled nuclear emulsions allowing the study of the energy spectrum of γ-quanta resulting from the meson (π^0) decay during each individual interaction. Six types of interactions were discovered, and they are briefly discussed. (CFSTI)

37657 CAUSALITY AND ASYMPTOTIC AMPLITUDE OF MESON-NUCLEON SCATTERING. Meiman, N. N. pp 258-81 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

It is often forgotten that the problem of the analytic continuation of physical amplitudes of meson-nucleon reactions into the complex plane with cuts solved by Bogolyubov, Medvedev, and Polivanov is not equivalant to proof of the analyticity of the retarded A^{ret} and advanced A^{adv} amplitudes. The $A_\infty^{ret}(s,t)$ and $A_\infty^{adv}(s,t)$ coinciding in the $s \to \infty$ asymptotic region with $A^{ret}(s,t)$ and $A^{adv}(s,t)$ are derived

for the case of scalar particles and can be used for the study of the asymptotic properties of amplitudes. From microcausality it follows without any further mathematical assumptions that $A_{ab}^{ret}(s,t)$ is analytic in the upper half-plane while $A_{ab}^{adv}(s,t)$ has the same property in the lower half-plane for all physical values of the momentum transfers. The asymptotic amplitudes satisfy the crossing-symmetry condition and increase as $s \to \infty$ slower than any exponential. This makes them suitable for the rigorous derivation of the ratios between the total particle and antiparticle scattering cross sections and for the derivation of a similar relation between differential high-energy fixed-t cross sections. (CFSTI)

37658 NONLEPTONIC DECAYS OF LONG-LIFE NEUTRAL K MESONS. Gal'per, A. M. pp 282-92 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

A brief survey of meson (K^0) properties is followed by a description of experiments in which the long-lived meson (K_2^0) was studied. (D.C.W.)

37659 CURRENT STATE OF WEAK INTERACTION PHYSICS. Okun, L. B. pp 295-307 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

Data are discussed concerning the mutual interaction of lepton currents ($e\nu$) and ($\mu\nu$) (existence of two neutrinos, neutron-lepton currents, squares of currents); lepton-neucleon current interaction (conserved vector current); lepton current-strangeness current interaction ($\Delta Q = \Delta S$, $|\Delta S| = 1$, $\Delta I = \frac{1}{2}$ rules and suppression of strangeness-nonconserving lepton decay); mutual interaction of hadron currents ($\Delta I = \frac{1}{2}$ rule, parity nonconservation of nuclear forces); the W boson, whose role in weak current interactions is similar to the role of photons during electric current interactions; and weak interactions at ultra high energies (weak interactions at small distances). (CFSTI)

37660 THE THEORY OF THE INTERMEDIATE VECTOR BOSON. Ioffe, B. L. pp 308-23 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

A presentation of the intermediate vector boson theory is given. The theory demands that the μ and β decay constants be essentially the same during the meson (W) weak decay and that the electromagnetic corrections to the G_μ/G_β ratio be essentially small. The experimentally observed coincidence of these two constants seems to favor the meson (W) transmitted interaction since the four-fermion interaction approach is unable to explain such a coincidence. The meson (W) mass should, according to the theory, be somewhere in between the one and several Bev limits; this supplies the upper boundary of the region within which one should search experimentally for such a particle. (CFSTI)

37661 UNITARY SYMMETRY AND WEAK INTERACTIONS. Shekhter, V. M. pp 324-31 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

The structure of the $j_1 = (\bar{\nu}_e e)$ and $j_2 = (\bar{\nu}_\mu \mu)$ current of the symbolic weak interaction quadrangle and tetrahedron is quite simple since it contains only a simple component. Currents j_3 and j_4 have a more complex structure, and if they are viewed as different components of the same unitary octet one encounters the following consequences: j_4 being an isospinor component, the lepton decay of hyperons and mesons-(K) must obey the $\Delta T = \frac{1}{2}$ rule; the unique j_4 structure satisfies also the $|\Delta S| = 1$ and $\Delta S = \Delta Q$ rules which are confirmed by experiments; if the axial constant and the vector constant are of the same order of magnitude, the fact that the strangeness-changing reactions are smaller than the strangeness-conserving cases by one order of magnitude leads to the requirement that the total current $J = j_1 + j_2 + j_3 + \theta j_4$ with $\theta \ll 1$; and the j_4 structure prescribes unique ratios between the squares of the constants of strangeness-changing reactions. After a discussion of the possible assumptions regarding the axial current structure, the theoretical predictions are compared with experimental data by Snow and Rousset. (CFSTI)

37662 HIGH ENERGY NEUTRINO EXPERIMENTS. Mukhin, A. I. pp 332-50 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

The experimental setup, equipment, methods, and results of the CERN high-energy neutrino experiment are described in detail. (CFSTI)

37663 PION β-DECAY. Mukhin, A. I. pp 351-9 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

One of the predictions of the conserved vector current theory is the magnitude of the rate of the $\pi^+ \to \pi^0 + \beta^+ + \nu$ process $\lambda_{theor} = 0.395\ sec^{-1}$. This leads to the ratio of $\pi \to \pi^0 + \beta + \nu$ to $\pi \to \mu + \nu$ of $1.01 \pm 0.03 \times 10^{-8}$. Of the three groups of experimentators working on the problem in Dubna, CERN, and Berkeley, the first two groups followed a similar path leading to superior results. The Dubna experimental setup, method, and results are described in considerable detail. Experimental results $R_{exp} = 1.1 \pm 0.2 \times 10^{-8}$ (Dubna) and $1.15 \pm 0.22 \times 10^{-8}$ (CERN) are quite consistent with the theoretical prediction. (CFSTI)

37664 THREE-PARTICLE LEPTONIC K-MESON DECAY. Smirnitskii, V. A. pp 360-74 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

Data on $K_{\mu 3}^+$, K_{e3}^+, $K_{\mu 3}^0$, and K_{e3}^0 decay are reviewed, covering correlations, form factor ratios, μ^+ and π^0 spectra during the $K_{\mu 3}^+$ decay, and the muon polarization during $K_{\mu 3}^+$ decay. (CFSTI)

37665 THE K $\to$ 3 π DECAY AND π-MESON LOW ENERGY INTERACTIONS. Anisovich, V. V. pp 375-89 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

The theoretical determination of the meson (π) scattering length from the K-3π decay data is reviewed. The theoretical results agree with experimental data if either one assumes that a_0 and $a_1 < 1$ (a_I – scattering length of mesons(π) with isospin I) and then $a_0 a_2 = -0.2 \pm 0.2$; or one assumes that a_0 is large ($a_0 = 1 - 3$) and then the agreement is good for $a_0 \sim 1$. At present, due to the large errors in experimental data one can not deduce more accurate conclusions about the meson (π) scattering length. (CFSTI)

37666 ELECTROMAGNETIC PROPERTIES OF THE NEUTRINO. Perelomov, A. M. pp 390-400 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

This is a survey of theoretically predicted or experimentally observed data from Soviet and Western references (published mostly during the past five years) concerning the charge, magnetic moment, and radius of the charge of the neutrino. (CFSTI)

37667 NEW EXPERIMENTAL DATA ON THE ELECTROMAGNETIC STRUCTURE OF NUCLEONS. Kharitonov, V. M. pp 403-22 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

A report is presented on experiments, experimental results, and interpretation of results concerning precise proton and neutron form factor measurements in the low momentum transfer region checks of the Rosenbluth formula; studies of proton structure at high momentum transfers; improvements in data comparing the scattering cross sections of electrons and positrons; and first experiments studying form factors in the time-like momentum transfer region. (CFSTI)

37668 PION PHOTOPRODUCTION. Baldin, A. M. pp 423-50 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

Following the exposition of the problem in general, its kinematics, its resonance and peripherial models, and the known experimental data, it is emphasized that the state of the problem is fully determined by the available experimental data and the degree of development of the theory of strong interactions. Future experiments should supply information about photoproduction amplitudes for energies

and angles satisfying the $t = t_{threshold}$ condition; cross sections at $\theta = 0$ and 180°, angles which are most sensitive to dispersion integral estimates and small nonresonant amplitudes; resonances (reliable quantitative data), elementary interactions, and vertexes; multiple pion photoproduction; and photoproduction of pions on protons and deuterons in the near-threshold region (such complete quantitative information could contribute to the establishment of the theory of strong interactions and also check the possible existence of the meson (π_2^0). (CFSTI)

Field Theory and Quantum Mechanics

37669 (D1-82-0389) ENERGY GAIN OF A LOW-ENERGY CHARGED PARTICLE IN A STANDING WAVE NEAR CYCLOTRON RESONANCE. Hall, Richard B. (Boeing Scientific Research Labs., Seattle, Wash.). Dec. 1964. 23p

Approximate expressions are derived for the energy gain of a charged particle as a result of either being reflected from or of passing entirely through an r-f standing wave. It is shown that energy gain is obtained only when a d-c magnetic field is present and commences further from cyclotron resonance as the r-f field amplitude increases. The exact equations of motion are numerically solved and curves showing energy gain, ratios of perpendicular to longitudinal energy and the time required for reflection are obtained. It is found that the approximate analysis predicts closely the actual phenomena. (auth)

37670 (IC/65/53) AN ANALYSIS OF THE STABILITY CRITERION. Boyce, J. F. (International Centre for Theoretical Physics, Trieste (Italy)). May 1965. 15p. Dep. mn.

High energy boundary conditions upon the basic Green's functions which limit the types of divergence arising in any approximational method of solution of a field theory are derived and shown to be related to the recently defined stability criterion. (auth)

37671 (IC/65/61) ON THE PRODUCT OF WICK POLYNOMIALS IN THE AXIOMATIC FIELD THEORY. Boehm, A.; Polivanov, M. (International Centre for Theoretical Physics, Trieste (Italy)). June 1965. 15p. Dep. mn.

A provisional definition of the product of Wick polynomial expansion of operators in axiomatic field theory is suggested. This definition is applied for the computation of the asymptotic forms of the currents in the model of quantum electrodynamics, which are shown to agree with the expressions of the renormalized canonical theory. (auth)

37672 (ORNL-TM-1172) MAGNETIC FIELD STORAGE CODES AND ORBIT CALCULATIONS. Rankin, Mozelle (Oak Ridge National Lab., Tenn.). June 18, 1965. Contract W-7405-eng-26. 8p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

Two codes to be used jointly for studying single particle orbits are described. After calculating the magnetic field quantities and their derivatives for an axisymmetric coil system, the first code stores them on magnetic tape. The second code then integrates the equations of motion using the magnetic quantities previously stored on tape. Since the values are only stored for a finite grid, a Taylor series expansion is used to obtain the field at the point called for in the integration procedure. Plots are produced to facilitate analysis of these orbits. (auth)

37673 (UCRL-11921) ANALYTICITY AS A FUNDAMENTAL PRINCIPLE IN PHYSICS. Chew, Geoffrey F. (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 28, 1965. Contract W-7405-eng-48. 19p. (CONF-640915-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Pisa Symposium on Natural Philosophy, Pisa.

The role of analyticity in established theories of macroscopic and atomic phenomena is briefly reviewed, with emphasis on the difficulty of using analyticity as a starting principle. Contrast is made with nuclear phenomena where experiments suggest the absence of arbitrary parameters and where analyticity of the S matrix seems attractive as an a priori theoretical postulate. The notions of maximal analyticity of first and second degree are discussed. (auth)

37674 A CONTRIBUTION TO EINSTEIN'S UNIFIED-FIELD THEORY. Pizzo, J.; Kronsbein, J. (Univ. of Florida, Gainesville). Am. J. Phys., 33: 528-31(July 1965).

The term unified-field theory is, at first, suggestive of the unification of only the gravitational and electromagnetic fields through a nonsymmetric tensor g_{ik}. This impression is incorrect in that the g_{ik} are not necessarily restricted to represent the gravitational plus electromagnetic fields alone. It is, however, known that the field equations of gravitation alone (as given in the general theory of relativity) are contained within the unified-field theory of Einstein. It is demonstrated that the covariant electrodynamic equations in the presence of a gravitational field are also included in the unified-field theory. (auth)

37675 PERATIZATION OF UNRENORMALIZABLE FIELD THEORIES. Guettinger, W.; Penzl, R.; Pfaffelhuber, E. (Universitaet, Munich). Ann. Phys. (N. Y.), 33: 246-71(June 17, 1965).

It is shown that there exists a cutoff-free built-in prescription in the formulation of unrenormalizable field theories of weak interactions, rendering these accessible to diagram and perturbation techniques and producing finite and physically significant results at each step of approximation even if the exact solutions are nonanalytic in the coupling constant. Being an extension of renormalization theory, the formalism provides a simple and rigorous basis for the peratization of weak interactions without suffering from the shortcomings of the heuristic method of Feinberg and Pais. The relation between the Bethe-Salpeter scattering equation and singular potentials is discussed. Some theorems concerning the essential singularities on the light cone of the Bethe-Salpeter wave function are proved and some examples are discussed. Approximation formulas for the scattering amplitude are deduced which, although originating from perturbation techniques, reveal precisely the nonanalytic structure in the coupling constant of the exact amplitude. (auth)

37676 AN EXAMPLE OF THE MANDELSTAM REPRESENTATION IN PERTURBATION THEORY. Federbush, Paul (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.), 33: 272-4(June 17, 1965). (MIT-2098-128)

A Feynman diagram that has three-particle intermediate states in all channels is studied. Choosing special values of the masses, in particular taking infrared divergent terms as certain masses go to zero, the spectral functions in this limit are calculated explicitly. They are nonzero in all three regions. (auth)

37677 ON THE NONLINEAR PROPERTIES OF RETARDED PRODUCTS. Streater, R. F. (Imperial Coll., London). Ann. Phys. (N. Y.), 33: 311-327(July 1965).

A set of functions $t(p_1, \cdots p_n)$ are postulated that satisfy the unitarity equations appropriate for time-ordered functions of n current operators, $n = 4, 5, \cdots$. In terms of functions t, $r_\alpha (p_1, \cdots p_n)$ of each order n is defined which correspond to the generalized retarded functions of axiomatic local quantum field theory. Using the technique of generating functionals, the corresponding "products of operators" T and R are defined. The $t(p_1, \cdots p_n)$ and $r_\alpha(p_1, \cdots p_n)$ are well defined as distributions in momentum space, possibly not tempered; and the time-ordered and retarded operators are also distributions in momentum space, and as operators in Fock space have reasonable domains of definition. The commutator $[R_\alpha, R_\beta]$ between any two retarded operators can be expressed as sums and differences between retarded operators of order n + m, where n is the order of R_α and m that of R_β. The various r_α-functions coincide in some region of momentum space, and any given r_α coincides with the t-function in the

region of momentum space appropriate to the function r_α. The R_α-operators trivially satisfy the Steinmann relations. Thus many of the "linear" properties of the retarded operators that follow from causality and Lorentz invariance also follow from unitarity, when no locality is assumed. (auth)

37678 INFRARED CONTRIBUTIONS TO INTERMEDIATE STATE SUMS IN QUANTUM ELECTRODYNAMICS. Perrin, R.; Lomon, E. L. (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.), 33: 328-359(July 1965). (MIT-2098-119)

A method was developed for incorporating the Bloch-Norsdsieck approximation into intermediate state sum expansions in quantum electrodynamics, so as to explicitly include the contributions of soft photons to these sums. This accomplishes the removal of infrared divergences usually incurred in approximations involving the cutting off of such intermediate state sums, and in addition, within the framework of such approximations, gives strong high energy convergence properties to the theory. The formalism developed is applied to modify a work on quantum electrodynamic dispersion relations. An asymptotic form for the electron's charge form factor is derived, and is shown to be consistent with second order perturbation theory, and a series expansion for the charge renormalization constant Z_3 is obtained, all of whose terms are finite, except for those which arise from states containing only hard photons and no pairs. In a separate development, a comparison is made of the various methods which were developed for treating the radiative corrections to scattering cross sections due to soft photons. (auth)

37679 THE INTERPRETATION OF THE SCHWARZSCHILD METRIC AND THE RELEASE OF GRAVITATIONAL ENERGY. McCrea, W. H. (London Univ.). Astrophys. Norvegica, 9: 89-94(1964).

It is shown that according to general relativity the smallest possible radius for a body of given mass is that giving the Schwarzschild singularity. It has the physical interpretation that the gravitational binding energy of a particle added to a body of this radius exactly cancels the proper mass of the particle. A condensation of exactly the singular radius could not, however, be formed in finite time. Thus in practice the Schwarzschild exterior metric is required only outside the singularity. The metric to be used inside this distance would represent the material there; so the question of the meaning of the Schwarzschild exterior solution inside the singularity can not arise in applications. If a body is formed with as nearly as possible the singular radius, then the energy released in the form of radiation in the process is between 50 and 100 percent the energy equivalent of the initial diffuse matter that goes to form the condensation. (auth)

37680 SOME GENERAL ASPECTS OF EINSTEIN'S THEORY OF RELATIVITY. Klein, O. (Univ. of Stockholm). Astrophys. Norvegica, 9: 161-9(1964).

Foundations of Einstein's general relativity theory, its application to the system of galaxies, and its relation to quantum theory are discussed. Einstein's method of achieving his theory, based on the equivalence principle, is briefly reviewed. The assumption that Einstein's theory implies a symmetry of nature beyond that contained in the principle of special relativity is considered. The question of boundary conditions for Einstein's gravitational field equations, gravitational radiation, cosmological theories based on general relativity, the relation of Mach's principle and the equivalence principle, and the relation of general relativity and quantum are discussed. (M.J.T.)

37681 SEPARATION OF POTENTIAL FIELDS. Nedyalkov, I. P. Izv. Fiz. Inst. s Aneb, Bulgar, Akad. Nauk, 13: 131-48(1965). (In Bulgarian)

Assume that a certain number of gravitating bodies C_1, C_2, ..., C_n, not necessarily homogenous, have a summary potential U. It is assumed that U is known for every point in the three-dimensional space which lies outside the bodies C_1, C_2, ..., C_n. Denote the potential of C_1 by U_1, the potential of C_2 by U_2, etc. By the concept "separation of the potential", a procedure is denoted by which the component potentials U_1, U_2, ... U_n can be found if the common potential U is known. It is demonstrated that the separation may be carried out on the basis of Green's theorem. The conditions for the uniqueness of this separation are clarified. It is shown that it is possible to reduce the problem of the analytical continuation of the electric potential to the corresponding problem of the gravitational potential. Another application is the separation of the Earth's magnetic field into internal and external. (auth)

37682 THE PLOTTING OF THE QUASI-POTENTIAL OF SPINOR FIELDS. Desimirov, G.; Stoyanov, D. Izv. Fiz. Inst. s Aneb, Bulgar, Akad. Nauk, 13: 149-56(1965). (In Bulgarian)

The possibility of plotting the quasi-potential of spinor particles in accordance with the theory of perturbations is discussed. The projecting character of Green's double-time function for the free bare particles and the proceeding method derived from this for the approach to this problem is elucidated. It is shown, for the class of problems in which one may restrict oneself to an instantaneous interaction, that the quasi-potential may be plotted in accordance with the theory of disturbances, and the equation of the quasi-optical approach coincides with Salpeter's well-known equation. For the problems in which the delayed effects are accounted for, an approximate examination of the problem is suggested; and an equation—the basic equation of the theory—is deduced which contains delayed members and which may be regarded either as an approximate equation of a quasi-optical approach in the case of a little delayed effect, or as the result of the requirement which has been additionally introduced in the theory for the quasi-potential to be plotted in accordance with the theory of perturbations. (auth)

37683 ON PEIERLS' METHOD OF QUANTIZATION. Froeyland, J. (Universitet, Oslo). Nuovo Cimento (10), 38: 1367-76(Aug. 1, 1965).

By slightly changing the quantum postulate of Peierls' method of quantization it is shown that it is possible to obtain commutation rules for half-integer spin fields without introducing extra operators. To illustrate other aspects of the postulate, trilinear commutation rules are deduced. Commutation rules for multicomponent Klein-Gordon fields for arbitrary spin are also obtained, and from these the usual commutation rules for arbitrary spin fields are obtained by means of projection operators. (auth)

37684 AN EXTENSION THEOREM FOR INHOMOGENEOUS ROTATION GROUPS. Sankaranarayanan, A. (Ames Lab., Ames, Iowa). Nuovo Cimento (10), 38: 1441-3(Aug. 1, 1965). (IS-1177)

A prescription for constructing the (n + 1)-dimensional Lorentz group from the n-dimensional inhomogeneous rotation group is presented. The method is purely algebraic. It is proved that, given the rotation and translation generators M_{ab} and p_c of the n-dimensional inhomogeneous rotation group, the homogeneous Lorentz group of the (n + 1)-dimensional space can be constructed and its generators are given by M_{ab} and $X_c = (i/(2\sqrt{+p_a^2}))\ [M_{cb}, p_b]_+$. The theorem is true even for pseudo-Euclidean rotations. (M.J.T.)

37685 STUDIES IN PERTURBATION THEORY. X. LOWER BOUNDS TO ENERGY EIGENVALUES IN PERTURBATION-THEORY GROUND STATE. Loewdin, Per-Olov (Univ. of Florida, Gainesville and Uppsala Univ.). Phys. Rev., 139: A357-72(July 19, 1965).

The eigenvalue problem $H\Psi = E\Psi$ in quantum theory is conveniently studied by means of the partitioning technique. It is shown that, if E is a real variable, one may construct a function $E_1 = f(E)$ such that each pair E and E_1 always bracket at least one true eigenvalue E. If E is chosen as an upper bound by means of the variation principle, the function E_1 is hence going to provide a lower bound. The reaction operator t associated with the perturbation problem $H = H_0 + V$ for a positive-definite perturbation V is studied in some detail, and it is shown that

a lower bound to t may be constructed in a finite number of operations by using the idea of "inner projection" closely associated with the Aronszajn projection previously utilized in the method of intermediate Hamiltonians. By means of truncated basic sets one can now obtain not only upper bounds but also useful lower bounds which converge towards the correct eigenvalues when the set becomes complete. The method is applied to the Brillouin-type perturbation theory, and lower bounds may be obtained either by pure expansion methods, by inner projections, or by a combination of both approaches leading to perturbation expansions with estimated remainders. The applications to Schrödinger's perturbation theory are also outlined. The method is numerically illustrated by a study of lower bounds to the ground-state energies of the helium-like ions: He, Li^{+}, B^{+2}, etc. (auth)

37686 QUANTUM ELECTRODYNAMICS WITHOUT DEAD WOOD. Dirac, P. A. M. (St. John's Coll., Cambridge, Eng. and Yeshiva Univ., New York). Phys. Rev., 139: B684-90(Aug. 9, 1965).

In quantum electrodynamics one can obtain a Hamiltonian which gives reasonable field equations in the Heisenberg picture, but which does not allow for solutions of the wave equation to represent physical states in the Schrödinger picture. The influence is that the Heisenberg picture is a good picture, the Schrödinger picture is a bad picture, and the two pictures are not equivalent. The usual proof of the equivalence of the two pictures fails because the state vector of the Schrödinger picture does not remain in Hilbert space. One can set up quantum electrodynamics entirely in the Heisenberg picture and thereby avoid the worst difficulties encountered in the Schrödinger picture. The theory takes a logical form and is not merely an assembly of working rules. It can be applied to the calculation of the anomalous magnetic moment and the Lamb shift and is then similar to the usual calculations of these effects, with a good deal of dead wood cut away. There is a problem concerned with the general interpretation of quantum mechanics when one can not use the Schrödinger picture, and some postulates are proposed for dealing with it. (auth)

37687 SOLUBLE MODEL FIELD THEORY WITH VERTEX FUNCTION. Bronzan, J. B. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 139: B751-4 (Aug. 9, 1965). (MIT-2098-130)

The Lee model is modified by the insertion of an elementary particle into the second sector with the coupling $U \rightarrow V + \theta$. The $UV\theta$ vertex function, the propagators, and all the renormalization constants of the theory are evaluated exactly, and the $V\theta$ scattering amplitude is given when both incoming and outgoing θ particles are off the energy shell. (auth)

37688 GRAVITATIONAL ACCELERATION OF FREE NEUTRONS. Dabbs, J. W. T.; Harvey, J. A.; Paya, D.; Horstmann, H. (Oak Ridge National Lab., Tenn.). Phys. Rev., 139: B756-60(Aug. 9, 1965). (ORNL-P-1159)

The gravitational acceleration of free neutrons from the Oak Ridge Research Reactor was measured in the evacuated 180-m flight path at Oak Ridge National Laboratory. The transmission edges associated with the ⟨100⟩ and ⟨002⟩ lattice spacings in a polycrystalline beryllium filter were used to define particular neutron velocities $v_{hkl} = (h/2md_{hkl})$ in the "slow beam." Boral filters permitted the selection of a "fast beam" which did not fall appreciably. The differences between the vertical positions of the slit image formed by the "fast beam" and of the two transmission edges (12.7 and 15.5 cm lower) were determined with the aid of least-squares fits to theoretical curves. An x-ray examination of the beryllium filter established the values for $2d_{hkl}$. It was found that the acceleration of free neutrons due to gravity is $g = 975.4 \pm 3$ cm/sec² [(100) planes] and $g = 973.1 \pm 7$ cm/sec² [(002) planes]. These may be compared with the local value $g = 979.74$ cm/sec² and McReynolds' early result $g = 935 \pm 70$ cm/sec². A recent suggestion of Spitzer that there might be a difference in g for the two vertical neutron-spin projections $\pm\frac{1}{2}$ does not appear to be present. No splitting greater than a few percent of g is found. (auth)

37689 GRAVITATIONAL RADIATION FROM A SPINNING ELLIPSOID OF UNIFORM DENSITY. Chin, Chaowen (Columbia Univ., New York and Goddard Space Flight Center, New York). Phys. Rev., 139: B761-(Aug. 9, 1965).

The gravitational radiation from a spinning ellipsoid and a spinning ellipse of uniform density is calculated. Upon comparison, the numerical coefficients are found to be smaller than that for a spinning rod. Radiation power vanishes when the ellipsoid and the ellipse are reduced to a spheroid and a circle, respectively. A classical rotating mass of uniform density bound by its gravitational field may be shown to be unstable against bifurcation into an ellipsoid if the period of rotation is short enough. Gravitational radiation can dissipate the angular momentum when bifurcation takes place. The calculation is used to estimate the energy-loss rate of a collapsing neutron star. It is shown that the relaxation time for dissipating angular momentum is around one second. (auth)

37690 10 EXACT GRAVITATIONALLY-CONSERVED QUANTITIES. Newman, E. T. (Univ. of Pittsburgh); Penrose, R. Phys. Rev. Letters, 15: 231-3(Aug. 9, 1965).

Although in the full nonlinear theory mass and momentum can be changed (carried away) by gravitational radiation, there is a set of 10 geometrical quantities, defined for asymptotically flat space-times, which have a quadrupole structure, and whose values cannot be altered in any way by gravitational radiation. For a general asymptotically flat space-time the quantities can be expressed as integrals at infinity on any null hypersurface which diverges to infinity. They are conserved in the sense that if space-time is empty near infinity and if η is any other null hypersurface diverging to infinity, then the new values will be the same as the old. This assumes that these null hypersurfaces open out into the future, so that outgoing gravitational radiation can escape between them. (J.F.P.)

37691 FUNDAMENTAL THEOREM IN QUANTUM OPTICS. Senitzky, I. R. (Army Electronics Command, Fort Monmouth, N. J.). Phys. Rev. Letters, 15: 233-5 (Aug. 9, 1965).

The interaction of the field (the source) with the detector (all given systems) is the interaction under consideration. Concepts and formalisms in quantum optics are simplified by the following theorem: All sources on which the effect of the detector is negligible may be treated as classical sources in the interaction under consideration. A corollary of this theorem is: The field acting on a quantum-mechanical system—when the sources are of the above type—consists of the superposition of a classical field and the vacuum field. The proof of the theorem is based on the connection between the quantum-mechanical (as distinct from classical) properties of a system and the measurability of these properties. In the proof the example of a mode of the electromagnetic field is considered to which both the source and detector are coupled. A feature of the theorem and associated formalism is the clear separation of classical and quantum-mechanical effects of the field, and the indication of the physical origin of each. (J.F.P.)

37692 ON RELATIVISTIC ANGULAR MOMENTUM THEORY. Winternitz, P.; Smorodinskii, Y. A.; Uhlir, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 113-19(July 1965).

Translated from Yadern. Fiz., 1: 163-72(Jan. 1965).

The components of the relativistic angular momentum are given explicitly in four coordinate systems in the Lobachevskii space of relativistic velocities. Complete sets of commuting operators are found which define these systems. The classical quantities corresponding to the invariants of subgroups of the Lorentz group are considered, together with the electromagnetic fields in which they are integrals of the motion. (auth)

37693 HIGHER CORRECTIONS IN THE FIELD THEORY OF WEAK INTERACTIONS. Gedalin, E. V.; Kancheli, O. V.; Matinyan, S. G. (Inst. of Physics, Academy of Sciences, Georgian SSR). Yadern. Fiz., 1: 881-8(May 1965). (In Russian)

The role of electromagnetic corrections in the field the-

ory of weak interactions is considered. Singularities of the amplitudes, vertex functions, and propagators, with respect to coupling constants, are discussed. (auth)

37694 DISCONTINUITIES ON CUTS CONNECTED WITH FERMION BRANCHING POINTS IN THE j-PLANE. Gurvits, S. A. (Moscow Inst. of Physics and Tech.). Yadern. Fiz., 1: 902-7(May 1965). (In Russian)

The extreme right branching points in the j-plane, due to fermion Regge poles, are considered. An expression is found for the discontinuities of the amplitude on the cuts connected with these singularities. (auth)

37695 THE LEHMAN REPRESENTATION AND PHOTON MASS. Vainshtein, A. I.; Sokolov, V. V.; Khriplovich, I. B. Yadern. Fiz., 1: 908-11(May 1965). (In Russian)

It is shown that the spectral representation gives no information on the photon mass, if the bare mass is equal to zero. It proves to be significant that the transverse part of a vector field is determined uniquely only for non-zero bare masses. (auth)

37696 THE ASYMPTOTICS OF DIVERGING FEYNMAN GRAPHS. Zav'yalov, O. I.; Stepanov, B. M. (Mathematical Inst., Academy of Sciences, USSR). Yadern. Fiz., 1: 922-34(May 1965). (In Russian)

A compact parametric representation is suggested for diverging Feynman diagrams. Formulas are obtained, establishing an unambiguous connection between the high-energy asymptotics of arbitrary scalar diagrams (including diverging ones) and the topological elements of the corresponding graphs. (auth)

37697 ON SPINORS IN GRAVITATION THEORY. Ogievetskii, V. I.; Polubarinov, I. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 48: 1625-36(June 1965). (In Russian)

Spinors in gravitation theory are treated as four-component objects which transform according to a nonlinear representation of the group of general covariant transformations. Interactions of a spinor field with gravitational, electromagnetic and other fields are constructed in accordance with the spinor transformation law thus derived. The interactions are expanded into a power series of the gravitational field which facilitates application of perturbation theory. (auth)

37698 INTRODUCTION TO FIELD THEORY AND DISPERSION RELATIONS. Hagedorn, R. A Pergamon Press Book. New York, The Macmillan Company, 1964. 132p. $5.00.

The hamiltonian formalism for field theory is reviewed. The S-matrix field theory is developed, and the construction of interpolating field operators from a given S-matrix is described. The properties of the field operators are deduced, including conditions on j(k), vacuum-state uniqueness, creation and annihilation operators, one-particle states and complete systems, asymptotic condition, and consequences of the causality of the field operators. The reduction technique is described, with discussions of matrix elements, the S-matrix in terms of vacuum expectation values of time-ordered products, and the retarded product. The dispersion relations are derived, giving the Dyson representation, properties of vacuum amplitudes in two-particle processes, dispersion relations for forward and non-forward scattering, detailed proof of the dispersion relations, proof of analyticity, and the one-particle contribution. (M.J.T.)

37699 SPECIFIC HEAT AND STRUCTURE FACTOR OF A MANY-BOSON SYSTEM. Scher, Harvey. Thesis, Syracuse, N. Y., Syracuse Univ., 1964. 84p.

A modification of the Rayleigh-Schrödinger perturbation theory is used to study the ground state energy of a system of interacting Bose particles. The ground state energy is calculated up to the third order of perturbation theory, and it is shown that the modified scheme circumvents the divergence difficulty associated with the standard application of the Rayleigh-Schrödinger perturbation method to the nonideal Bose gas. The liquid structure factor of the Bose gas is calculated and the expansion parameter in the perturbation method is exhibited. The liquid structure factor is shown to be in qualitative agreement with the experimental values at high momentum. The investigation is extended to the thermodynamic properties of the nonideal Bose gas. To this end the lowest order Hamiltonian is used. The partition function is calculated and expressions for the fractional occupation of the zero momentum mode of the Bose gas and the chemical potential are obtained. Expressions are obtained for the internal energy and the specific heat from the partition function. The specific heat is in good qualitative agreement with the experimental specific heat for values of the parameters obtained from estimates of these parameters for liquid helium. A discontinuity is obtained in the specific heat at the critical point, which is proportional to a dimensionless parameter characterizing the potential strength and is also proportional to the rate of depletion of the zero momentum mode with increasing temperature. It is shown that the theory holds for a range of temperatures from absolute zero to above the critical point. Results are incuded for both positive and negative values of the potential strength near the critical point. (Dissertation Abstr.)

37700 SOFT QUANTUM RADIATIONS IN QUANTUM ELECTRODYNAMICS. Kheifets, S. A. pp 451-5 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

A survey is presented of simplifications and modifications in the perturbation calculations, total cross section expressions (absence of elastic processes), and energy and angular distributions (of particles in final states) encountered during soft quanta emission calculations in quantum electrodynamics. (CFSTI)

37701 INTENSITY EFFECTS IN QUANTUM ELECTRODYNAMICS. Gol'dman, I. I. pp 456-71 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

In view of the existence of laser-produced photon beams of extremely high intensity, elementary processes involving collisions of more than two particles are entering the domain of experimental verification. The presentation of graphs of the processes in the presence of large photon intensities is followed by the presentation of the solution of the Dirac equation in the presence of plane electromagnetic waves, physical analysis of the solution, questions of normalization and invariance of $\xi^2 = e^2A^2/m^2c^4$, the monochromatic wave case, pair production below the two-particle threshold, and Compton scattering on relativistic electrons (energy relations, cross sections, small and large ξ cases, total cross section). (CFSTI)

Geophysics

Refer also to abstract 37930.

37702 (AD-608474) LARGE SCALE FLUCTUATIONS OF THE IONOSPHERE. Bibl, K. (Ionosphaeren-Institut, Breisach (West Germany)). July 15, 1964. Contract AF61(052)-623. 56p. (AFCRL-64-900; IIB-12). CFSTI, $3.00 cy, $0.50 mn.

By statistics based on ionogram data of three European stations amplitudes and quasi-periods of the fluctuations and their directions are determined. Different periods of the day, seasons and in- or de-creasing changes are treated separately. The oscillations found tend to produce higher electron density during downwards movement. (auth)

37703 (AD-611324) CURRENT DENSITIES IN VISUAL AURORAS. Scientific Report No. 7. Omholt, A.; Lorentsen, H. (Norst Institutt for Kosmish Fysikk, Oslo and Oslo Univ., Blindern (Norway). Fysisk Institutt). [1964]. Contract AF61(052)-680. 20p. (AFCRL-65-58). CFSTI, $1.00 cy, $0.50 mn.

The magnetic perturbations associated with quiet auroral forms with a fairly simple geometry (auroral arcs, broad bands, and glow) were studied, using the magnetic records from stations in and near the auroral zone. The north-

south spacing between the stations was 60–80 kms. From the height distribution of auroral luminosity and the other parameters involved the Pedersen and Hall conductivities were computed as functions of height during the aurora. From these curves it is seen that the vertical thickness of the conducting layer is about 25 km, regardless of whether Hall or Pedersen currents are the dominating depends on the direction of the electric field applied and the possibility of creating a polarization field across the arc or band. It is deduced that in all the auroral forms the current densities must be a few times 10 to the minus 9th power A/sq cm and the electric field of the order of magnitude 0.001 V/cm. (auth)

37704 (N64-23372) INFRASONIC WAVES FROM THE AURORAL ZONE. Maeda, Kaichi (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center); Watanabe, Tomiya (British Columbia Univ., Vancouver). June 1964. 44p. (NASA-TN-D-2138). $1.25(CFSTI).

Pulsating auroras are proposed as a source of the infrasonic waves associated with geomagnetic activity reported by Chrzanowski, et al. One of the most plausible generation mechanisms of these long-period pressure waves is the periodic heating of the air around 100 km, corresponding to the auroral coruscation reported by Campbell and Rees. To show the energetic relation between source input and pressure change at sea level, some theoretical calculations are performed by using a simple model of auroral distribution in the isothermal atmosphere. (auth)

37705 (N64-27247) THEORETICAL STUDIES OF PROTONS IN THE OUTER RADIATION BELT. Nakada, M. P.; Dungey, J. W.; Hess, W. N. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1964. 14p. (NASA-TM-X-55007). CFSTI, $1.60 cy.

The variations in the energy spectra with pitch angle and L of the relatively stable 0.1 to 5 Mev protons in the outer radiation belt were in good agreement with the results of a model that permits rapid motion of the protons in L space. In this model, the protons violate the third adiabatic invariant of trapped particle motion but do not violate the first two adiabatic invariants. Changes in fluxes with L are not consistent with Liouville's theorem. Both the departure from Liouville's theorem and variations in energy spectra seem to indicate that the source of these protons is at large L. (auth)

37706 (N64-27250) SOLAR CYCLE CHANGES IN INNER ZONE PROTONS. Blanchard, Robert C.; Hess, Wilmot N. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar. 1964. 33p. (NASA-TM-X-55013). CFSTI, $3.60 cy.

Time-dependent calculations of the inner Van Allen belt proton population show that large changes of the population up to a factor of 50 take place during the solar cycle. The effect is most pronounced for the region of B-L space corresponding to minimum altitudes of 300 to 700 km. Because different energy protons respond to the changing solar cycle at different rates, the proton energy spectra change with time also. (auth)

37707 (N64-29197) THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF ELECTRON DENSITY AND COLLISION FREQUENCY IN THE LOWER (D AND E) REGIONS OF THE IONOSPHERE BY RESEARCH ROCKET RADIO TRANSMISSIONS DURING THE IQSY USING DIFFERENTIAL ABSORPTION, FARADAY ROTATION AND MASS SPECTROMETRY. Second Semiannual Status Report February 1, 1964–July 31, 1964. Skaperdas, D.; Knoebel, H. (Illinois Univ., Urbana. Coordinated Science Lab.). June 10, 1964. 21p. (NASA-CR-56939). CFSTI, $2.60 cy.

A rocket was fired as part of a series of experiments conducted under a synoptic IQSY program. The experiment utilized a Nike-Apache rocket and part of its 60-pound payload, which was sent 105 miles into the atmosphere. The purpose was to measure the differential absorption and Faraday rotation for the determination of electron collision frequency in the D region. The system used to make these measurements is described, and the data obtained is presented. (auth)

37708 (N64-33160) CYCLOTRON EXCITATION OF HYDROMAGNETIC EMISSIONS. Final Report, January 16, 1964 - April 16, 1964. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Contract NAS5-3656. 54p. (NASA-CR-59199). CFSTI, $3.00 cy.

From a study of frequency-time characteristics of signals received at four widely separated low-latitude stations, the existence of a low-level sub-elf emission, which is almost always present during the nighttime hours, was ascertained. A brief analysis of amplitude-time hydromagnetic-emission data from Palo Alto and Kauai demonstrated a pronounced ionospheric attenuation effect that verifies previous work on attenuation of hydromagnetic waves in the ionosphere. The theoretical maximum trapped-particle loading of field lines in the magnetosphere is derived. The result is utilized in the cyclotron excitation of hydromagnetic emissions. A new model is presented that explains a number of observed hydromagnetic-emission characteristics. (auth)

37709 (N64-33627) MAGNETIC EFFECTS OF THE QUIET TIME PROTON BELT. Hoffman, R. A.; Bracken, P. A. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). June 1964. 58p. (NASA-TM-X-55078). CFSTI, $3.00 cy.

An analysis of the magnetic effects of the quiet-time proton belt was performed with data obtained from a proton detector aboard Explorer XII. From the measured energy spectra, intensities, and pitch angle distributions of the protons with energies above 100 kev, the current density on a magnetic meridian plane was calculated using the theory of Akasofu and Chapman, modified to eliminate several simplifying assumptions. The algebraic sum of all the currents was 0.59 million amperes, and the magnetic moment of the current loop was $0.029M_E$. From the electric current distribution the magnetic perturbations on the meridian plane were obtained. At the magnetic equator on the earth's surface the proton belt produced a 9γ decrease in the field in comparison with the 38γ decrease reported by Akasofu, Cain, and Chapman based on some preliminary data from the same detector. The maximum perturbation appeared at L = 3.6 on the magnetic equator, where the field attained a value of -23γ. (auth)

37710 (NBS-TN-210) AN ATLAS OF SOLAR FLARE EFFECTS OBSERVED ON LONG VLF PATHS DURING 1961. Chilton, C. J.; Steele, F. K.; Crombie, D. D. (National Bureau of Standards, Boulder, Colo. Central Radio Propagation Lab.). Mar. 13, 1964. 37p. $0.30(GPO).

Effects produced by 37 solar flares on four long vlf paths during 1961 are shown and tabulated. (auth)

37711 (NP-15106) TABLES OF NEUTRAL ATMOSPHERIC PROPERTIES AS A FUNCTION OF SOLAR ACTIVITY AND LOCAL TIME FROM 90 to 10,000 KM. Anderson, A. D.; Francis, W. E. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Mar. 1965. 73p.

A semitheoretical model of the upper atmosphere was constructed to allow the calculation of the primary neutral atmospheric properties (temperature, density, pressure, and composition) from 90 to 10,000 km as a function of local time and solar activity. The results of these calculations are presented in tables for various local times and solar activities ranging over a solar cycle. The density in the exosphere is corrected for the escape of atomic hydrogen from the earth's atmosphere. In order to check the model, the temperature, molecular weight, density, and number densities for O, O_2, and N_2 are computed from 130 to 200 km for conditions of solar activity and local time corresponding to measurements made by Nier et al. (1964) at White Sands on June 6, 1963. The observed properties and those calculated with the model differ by an average of 10%. (auth)

37712 ON SOLAR IMPOSED SMALL DAYLIGHT FLUCTUATIONS IN THE GEOMAGNETIC FIELD. Gjellestad, Guro; Dalseide, Helge (Univ. of Bergen). Astrophys. Norvegica, 9: 123-34(1964).

A study of monthly means of the three-hour range geomagnetic character-numbers, K-indices, shows that small fluctuations, characterized by daytime/summer maxima (called J after Mayaud), are present at five observatories, representing approximately a meridian section from a point just inside the auroral zone (geomagnetic lat 71°) through this zone (Tromsö) to geomagnetic latitude 58°. It is suggested that J is probably a global effect, intimately connected with the sun. The sun's contribution is a more or less purely geometrical effect, increasing with the sun's declination. Not only is J superimposed on the solar quiet daily variation, but it appears to be superimposed on the general geomagnetic activity connected with the solar activity. Another effect with nighttime/equinoxial maxima (called N) is also present. J and N must have very different physical causes. It is suggested that J appears as a statistically mean effect on the geomagnetic field of the mean solar wind. J is a relatively small effect, which may be masked by stronger effects if absolute values are studied. The semilogarithmic scale of the K-index proved convenient for studies of this small effect. (auth)

37713 ELECTROMAGNETIC RADIATION IN THE 8 kc/s BAND OBSERVED NEAR THE AURORAL ZONE. Harang, L. (Norwegian Defence Research Establishment, Kjeller, Norway and Inst. of Theoretical Astrophysics, Blindern, Norway). Astrophys. Norvegica, 9: 135-46 (1964).

Enhanced 8-kc radiation was recorded during recent years at Tromsø. The noise power of the bursts is of the order 10^{-15} to 10^{-16} watts/m^2c. The appearance of vlf bursts simultaneous with geomagnetic variations, ionospheric absorption measured through riometer, and auroral luminosity was studied. There is a close connection between the appearance of small geomagnetic storms and vlf bursts. During strong negative geomagnetic disturbances the vlf amplitudes decrease to zero. During strong riometer deflections (on 28 Mc) representing absorption in the 3-9 db range the vlf amplitudes disappear. During weak absorption with deflections representing absorption in the 0.3-0.6 db range vlf emissions often appear which coincide with the faint absorption peaks. The vlf emission is thus associated with the intrusion of charged particles in the ionosphere, simultaneously producing ionization in the lower part on the E-layer accompanied by various degrees of absorption. The mean diurnal curve shows that the vlf bursts appear only in the time interval 18-24 MET; bursts are not recorded during the late night hours or during daylight. Directional studies using alternatively E-W and N-S frames were made. Vlf bursts come in with appreciable intensities on both frames, and no distinct preference of direction in this area close to the auroral zone could be established. Studies of amplitude distribution were made, and in several cases the build up of strong individual spikes occurred. The observations indicate that the emissions start as isolated strong spikes appearing at random. They increase in number and finally fill up the time intervals, producing a continuous noise train. Records are presented which show the coincidence of vlf emissions and positive deflections on the 28 Mc riometer appearing at the start of a geomagnetic disturbance. (auth)

37714 THE ORIGIN OF M-REGION GEOMAGNETIC STORMS. Billings, Donald E.; Roberts, Walter Orr (High Altitude Observatory, Boulder, Colo.). Astrophys. Norvegica, 9: 147-50(1964).

The recent solar wind theory of Parker can be invoked to explain certain statistically persistent traits of recurrent geomagnetic storms of M-region type. To do this it is necessary to suggest a configuration of the solar atmospheric temperature distribution near moderate or weak active solar regions characterized by lower radial temperature gradients at the peripheries of the regions than at their centers. (auth)

37715 ELECTRIFICATION IN THE EARTH'S ATMOSPHERE FOR ALTITUDES BETWEEN 0 AND 100 KILOMETERS. Cole, R. K. Jr.; Pierce, E. T. (Stanford Research Inst., Menlo Park, Calif.). J. Geophys. Res., 70: 2735-49(June 15, 1965).

An attempt is made to unite the concepts of atmospheric electricity and of lower ionospheric physics by using a common theoretical approach to derive profiles of electron and ion densities from 0 to 100 km. Relations between height and the rate of ion production that apply to average geographical and temporal conditions are used, together with selected values of attachment, detachment, and recombination coefficients. The uncertainty in and range of variation of these coefficients are discussed, and some examples given of the associated variability in the derived electron and ion density profiles. Estimates of collisional frequencies are used in conjunction with the electron and ion density information to obtain profiles of conductivity versus height. Below some 40 to 50 km, ionic conductivity is dominant. Deductions regarding mobility and its relation to ion-clustering are considered. It is demonstrated that when ionization is being produced below about 40 km, the radio wave absorption due to ions is much more important than that caused by electrons. It is also shown that any effects on atmospheric electricity observations at the ground associated with ionizing fluxes in the upper atmosphere are probably due to stratospheric space charges rather than to changes in conductivity at high altitudes. The applications of the conductivity profiles to radio wave propagation at v-l-f and e-l-f are briefly examined. (auth)

37716 INTERPLANETARY MAGNETIC FIELD ASYMMETRIES AND THEIR EFFECTS ON POLAR CAP ABSORPTION EVENTS AND FORBUSH DECREASES. Haurwitz, M. W.; Yoshida, S.; Akasofu, S.-I. (Univ. of Alaska, College). J. Geophys. Res., 70: 2977-88(July 1, 1965).

A flare plasma cloud model is proposed which has a characteristic magnetic field asymmetry that develops as a natural consequence of the interaction between the expanding solar plasma region and the spiral magnetic field set up by the solar wind. It is a basic characteristic that leads to an understanding of various solar-terrestrial relations, such as observed asymmetries in polar cap absorptions and Forbush decreases. These events show pronounced differences, depending on whether the associated flares are east or west. Both a large increase in absorption at the time of storm sudden commencement and a large Forbush decrease are caused almost exclusively by eastern and central flares but not by western flares. The east-west differences require an asymmetrical trapping of solar protons and an asymmetrical field configuration relative to the sun-earth line. (auth)

37717 THE EARTH'S MAGNETIC TAIL. Ness, Norman F. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 70: 2989-3005(July 1, 1965).

Extensive measurements of the magnetic field of the earth at distances greater than approximately $7R_e$ (earth radii) were performed by the Imp 1 satellite. These magnetic field measurements began on November 27, 1963, and ended on May 30, 1964. During this six-month interval, the apogee-earth-sun angle in solar ecliptic coordinates decreased from 336° to 156°. The apogee of the satellite was $31.7R_e$, and the range of the magnetometers was between 0.25 and 300γ. This paper is concerned principally with the topology of the magnetic field within the magnetosphere and the position of both its boundary and the detached collisionless bow shock wave. The geomagnetic field is observed to trail out far behind the earth in the antisolar direction, thus forming a magnetic tail. Magnetic field strengths of approximately 10 to 30 γ are observed out to satellite apogee. The diameter of the magnetosphere at a distance of $30R_e$ behind the earth is found to be approximately $40R_e$. The direction of the field is parallel to the earth-sun line and in the antisolar direction below the solar magnetospheric equatorial plane and in the solar direction above this plane. A neutral surface separating antisolar directed fields in the southern hemisphere from solar directed fields in the northern hemisphere has been detected over a large area. This experimental result suggests the development of quantitative theories explaining the aurora, gegenschein, day-night asymmetry, and formation of the radiation belts. On the basis of a preliminary review of the data, it appears that

the geomagnetic field trails out far behind the earth following the flow field of the solar plasma to a distance far beyond the orbit of the moon. No termination of the magnetic tail is detected or suggested by the data. Thus, the earth can be compared to the nucleus of a comet, the radiation belts and co-rotating magnetosphere being the coma and the magnetic tail being the cometary tail. (auth)

37718 NIGHTSIDE MAGNETOSPHERE CONFIGURATION AS OBTAINED FROM TRAPPED ELECTRONS AT 1100 KILOMETERS. Williams, Donald J. (Johns Hopkins Univ., Silver Spring, Md.); Mead, Gilbert D. J. Geophys. Res., 70: 3017-29(July 1, 1965).

Using data from the polar orbiting satellite 1963 38C, the diurnal variation of trapped electrons of energies $E_e \geq 280$ kev and ≥1.2 Mev during magnetic quiet was obtained. This diurnal variation is measured as a latitude shift for constant electron intensity and is obtained as a function of invariant magnetic latitude. All the data were obtained for dipole orientations within ±12° from the normal to the earth-sun line and for satellite positions within 8° of the noon-midnight meridian. Assuming conservation of the adiabatic invariants as these trapped electrons drift in the magnetosphere, it has been possible to obtain a nightside magnetic field configuration that fits the observed diurnal variations. A dayside configuration that agrees with experimental observations was used. The nightside configuration so determined displays an extended field line geometry and a current sheet in the magnetic equatorial plane. The field due to this current sheet is found to range from 20 to 40 gammas adjacent to the sheet, depending upon the radial extent of the sheet. A field line configuration in the noon-midnight meridian is presented. The nightside trapping boundary as defined by field line closure was found to occur at 1100 km at 67°, in agreement with observed boundaries at 1100 km of ~67° for both ≥40- and ≥280-kev electrons. The situation on the dayside is different and is discussed. (auth)

37719 ELECTRON FLUXES AT 1000 KILOMETERS ASSOCIATED WITH THE TAIL OF THE MAGNETOSPHERE. McDiarmid, I. B.; Burrow, J. R. (National Research Council, Ottawa). J. Geophys. Res., 70: 3031-44(July 1, 1965).

Particle detectors on board the Alouette 1 satellite at an altitude of 1000 km occasionally detect electron fluxes at latitudes above the region where the boundary of the outer Van Allen radiation zone normally occurs. The latitude profiles of the electron fluxes are usually in the form of a fairly narrow spike, and some of the events have extremely high intensities. Directional intensities of electrons above 40 kev approaching 10^9 cm^{-2} sec^{-1} ster^{-1} have been observed. The high-latitude electron fluxes are found preferentially on the night side of the earth on lines of force which presumably connect to the "tail" of the magnetosphere and at times when enhanced electron fluxes are observed in the outer radiation zone. It is suggested that electrons generated in the tail of the magnetosphere may form an important source of electrons for the outer radiation zone. (auth)

37720 PRELIMINARY REPORT ON DETECTION OF ELECTROSTATIC ION WAVES IN THE MAGNETOSPHERE. Scarf, F. L.; Crook, G. M.; Fredricks, R. W. (TRW Space Tech. Labs., Redondo Beach, Calif.). J. Geophys. Res., 70: 3045-60(July 1, 1965).

The Lockheed-Aerospace P11 satellite (1964-45A) launched into a polar eccentric orbit on August 15, 1964, included in its payload a v-l-f electric field experiment supplied by TRW Space Technology Laboratories. Measurements in the frequency range 1.7 to 14.5 kc/s reveal that the indicated background rarely falls below 10^{-2} volt/m and that sustained field enhancements with E ≃ 20-100 mv/m are generally detected in regions where energetic electrons are precipitated from the Van Allen belts. The experiment is described; some early results are presented; and an interpretation in terms of electrostatic ion waves is given. The possibility that large-amplitude ion waves cause diffusion across L shells and magnetospheric electron acceleration is also discussed. (auth)

37721 A MECHANISM FOR ENERGIZING ELECTRONS IN THE MAGNETOSPHERE. Swift, Daniel W. (Univ. of Alaska, College). J. Geophys. Res., 70: 3061-73(July 1, 1965).

An electrodynamic heating mechanism is proposed to account for the precipitation of kilovolt energy electrons during an auroral disturbance. It is shown that given the existence of an electric field transverse to the geomagnetic field caused by space charges in the magnetosphere, currents will flow along the magnetic field connecting the space charges to the conducting ionosphere. It is shown that the longitudinal current deduced from magnetic observations can be of sufficient intensity to become unstable, resulting in growing ion acoustic waves. In the nonlinear limit these waves tend to inhibit current flows in a collisionless plasma and transform the ordered flow energy into turbulent energy, thus resulting in extreme electrodynamic heating of the electrons. The flow of these "hot" electrons down the geomagnetic field lines is believed to be responsible for the bright aurora and accompanying ionospheric absorption. (auth)

37722 ON THE EFFECT OF RESONANT MAGNETIC-MOMENT VIOLATION ON TRAPPED PARTICLES. Chang, D. B.; Pearlstein, L. D. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Geophys. Res., 70: 3075-83(July 1, 1965).

A quasilinear diffusion equation for particles interacting with transverse waves propagating along a homogeneous magnetic field is constructed to study the effect of resonant magnetic-moment-violating interactions. It appears that quite anisotropic flat-helix particle distributions can result from such interactions. (auth)

37723 ON THE INTERCHANGE STABILITY OF THE VAN ALLEN BELT. Chang, D. B.; Pearlstein, L. D.; Rosenbluth, M. N. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Geophys. Res., 70: 3085-97(July 1, 1965).

The interchange stability of the Van Allen belt is studied in the electrostatic approximation. The destabilizing currents are obtained from the description of the particle motion developed by Northrup and Teller when the magnetic moment and bounce actions are invariant. The stabilizing currents are described by the three-fluid (electrons, ions, and neutral particles) zero-temperature dielectric tensor discussed by Fejer. For frequencies of the order of the azimuthal drift periods of the energetic particles in the belt, the stabilizing currents arise primarily from the ionosphere. With a reasonable choice of belt parameters, the energetic particles appear to be quite stable against interchanges for the electron densities which obtain in the ionosphere during the daytime, but are near marginal stability for nighttime ionospheric densities. (auth)

37724 ATMOSPHERIC DENSITY EXPERIENCED BY RADIATION BELT PROTONS. Cornwall, John M.; Sims, Allen R.; White, R. Stephen (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res., 70: 3099-3111(July 1, 1965).

The mean atmospheric density encountered by trapped particles in the earth's radiation belt is calculated. The Harris-Preister model of the atmosphere below 1000 km, smoothed into the Johnson model above 1000 km, is used to compute the density for two different times in the solar cycle. The density averaged over the solar cycle is also computed. Two different fits to the magnetic field, the Jensen and Cain 48- and the Jensen and Whitaker 512-coefficient fields, are used. These mean atmospheric densities are combined with the proton injection coefficients for cosmic-ray albedo neutron decay of White, Austin, and Dragt and with the data of Freden and Paulikas and of Brown to find the region of B-L space where cosmic ray albedo neutron decay and atmospheric ionization losses occur. For L < 1.9 the experimental data and the theory are in agreement within the uncertainties introduced by the model atmospheres and the trajectories in the model magnetic field. At higher L values, an additional large loss mechanism is needed. The density calculated from the 512-coefficient magnetic field gives better agreement with the theory and data than the 48-coefficient magnetic field. The Johnson increase in the atmospheric hydrogen density during solar minimum gives better agreement than the corresponding Harris-Preister decrease. (auth)

37725 SPATIAL VARIATION OF THE INNER ZONE TRAPPED PROTON SPECTRUM. Freden, S. C. (Max-Planck Institut fur Extraterrestrische Physik, Garching, Ger. and Aerospace Corp., El Segundo, Calif.); Blake, J. B.; Paulikas, G. A. J. Geophys. Res., 70: 3113-16(July 1, 1965).

The omnidirectional differential spectrum of trapped protons was measured in the energy range from 10 to 200 Mev in August 1964. At $L \gtrsim 1.3$ and $B \approx 0.20$, the measurements yield a spectrum that is the same as that measured in 1960 by Freden and White. At L values above about 1.4, there is a sharp increase in the proton flux below ≈35 Mev compared with the spectrum for $L \gtrsim 1.4$. The differential spectrum for $E_p \gtrsim 35$ Mev at $L \gtrsim 1.4$ can be represented by a power law of the form E^{-n}, where E is the proton energy. The exponent n is found to be a function of B and L. For example, at $L = 1.6$, $B/B_0 = 1.0$, $n = 3.75$; and at $B/B_0 = 3.0$, $n = 2.3$. At $L = 2$, $B/B_0 = 3.0$, $n = 4.2$, and at $B/B_0 = 6.0$, $n = 3.4$. The spectrum of protons above 55 Mev does not show the same B, L dependence. These data are evidence that at least two important sources of trapped protons exist in the same region of space. (auth)

37726 A PECULIAR TYPE OF DAYTIME ABSORPTION IN THE AURORAL ZONE. Ansari, Ziauddin A. (Univ. of Alaska, College). J. Geophys. Res., 70: 3117-22(July 1, 1965).

By means of a chain of riometers with antennas pointed in different directions along the magnetic meridian at College, Alaska, a peculiar type of daytime radio-wave absorption was identified in the auroral zone. Unlike the typical auroral absorption which varies in an irregular manner in space and time, the peculiar daytime absorption shows little fluctuation with time and is usually much stronger to the north of College than to the south. It is shown that the characteristics of the absorption event can be explained in terms of the ionizing effects of a steady beam of primary auroral particles that slowly moves from the north of College to the south and whose intensity undergoes a pronounced decrease with its southward motion. (auth)

37727 CORRELATED AURORAL AND GEOMAGNETIC MICROPULSATIONS IN THE PERIOD RANGE 5 TO 40 SECONDS. Victor, Laurence J. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 70: 3123-30(July 1, 1965).

Simultaneous observations made of auroral and geomagnetic fluctuations at Byrd Station during the antarctic winter of 1961 are reported. The diurnal variation and period spectrums of regular pulsations in the period range 5 to 40 sec are presented. A peak-for-peak analysis of the fluctuations shows a strong correlation between the auroral fluctuations and the regular Pc 3 micropulsations. These correlated pulsations are most frequent in the post-midnight hours and are distinguished from the impulsive events occurring in the pre-midnight hours. (auth)

37728 DRAG AND PROPULSION OF LARGE SATELLITES IN THE IONOSPHERE: AN ALFVEN PROPULSION ENGINE IN SPACE. Drell, S. D.; Foley, H. M.; Ruderman, M. A. (Jason Div., Inst. for Defense Analyses). J. Geophys. Res., 70: 3131-45(July 1, 1965).

There is a motionally induced charge separation in a conductor moving across magnetic field lines. This change may be conducted away, resulting in a d-c current flow through the conductor if it moves through a plasma. The generation of Alfvén waves is a mechanism particularly effective for circulating the charge for very large conductors moving in or above the earth's ionsphere. This mechanism is studied and, when applied to the analysis of the orbit of the Echo satellite, is found to give rise to a significant damping of the motion as mechanical energy is converted to that of Alfvén radiation. The calculated drag is comparable to that observed for the orbit of Echo 1 and attributed in earlier studies entirely to the mechanical drag of considerable nonionized atmospheric density. Perturbations in electron density associated with this current flow may in appropriate circumstances be detectable even thousands of kilometers away from such a high-altitude satellite. The drag can be changed to a propulsion mechanism when a source of electrical power is available on the satellite. Up to fifty per cent of the expended power is available for pushing a space vehicle across an ambient magnetic field. (auth)

37729 LABORATORY EXPERIMENT ON THE DISTURBANCE OF ENVIRONMENTAL CONDITIONS BY PRESENCE OF SOUNDING ROCKETS. Kawashima, Nobuki (Japan Atomic Energy Research Inst., Tokyo). J. Geophys. Res., 70: 3203-10(July 1, 1965).

A laboratory experiment on the disturbance in the surrounding medium caused by the re-entry of traveling rockets into the environmental atmosphere has been performed with the use of a plasma from a plasma gun. The experiment is so arranged as to simulate the phenomena in the ionospheric region. The magnetic field is applied both perpendicular and parallel to the plasma stream. The formation of a downstream wake has been observed in the collision-dominant region. This downstream wake gradually disappears as the plasma stream becomes collision-free. For a parallel magnetic field, a disturbance propagating upstream has also been observed when the plasma flow was sub-Alfvénic. (auth)

37730 GEOMAGNETIC AND SOLAR DATA. Lincoln, J. Virginia (ed.) (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 70: 3227-8(July 1, 1965).

Data on sudden commencements and solar-flare effects in the third quarter of 1964 are presented, together with sunspot numbers and data on geomagnetic activity for Feb. 1965. (D.C.W.)

37731 A COMPARISON OF THE DIFFERENT EMPIRICAL RELATIONSHIPS THAT HAVE BEEN SUGGESTED BETWEEN SURFACE MAGNETIC INDICES AND SOLAR WIND VELOCITIES. Hirshberg, Joan (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res., 70: 3229-30(July 1, 1965).

The empirical equations given by Snyder and by Maer and Dessler for the relation between the magnetic disturbance indices and the solar wind velocity are compared by expressing them in terms of the same disturbance index. (D.C.W.)

37732 CONCERNING α AT SEVEN EARTH RADII. Ray, E. C. (Rand Corp., Santa Monica, Calif.). J. Geophys. Res., 70: 3238-9(July 1, 1965).

An approximate Stormer integral that holds in much of the phase space of a particle moving in a magnetic field was previously derived. A numerical example involving an application of this integral to particles trapped in a magnetic-field model of the solar-wind cavity as obtained by Mead is treated. It is concluded that deformation of the geomagnetic field by the solar wind is unimportant in describing the behavior of trapped particles with $L \leq 7$ earth radii. (D.C.W.)

37733 ELECTRON AND PROTON FLUXES IN THE TRAPPED RADIATION BELTS ORIGINATING FROM AN ORBITING NUCLEAR REACTOR. Ringle, John C. (Air Force Cambridge Research Labs., Bedford, Mass.). Nucl. Sci. Eng., 22: 492-4(1965).

A SNAP-50 reactor was assumed to be in a geographic equatorial orbit at 1000 km and to operate at its maximum power level of 8Mw(t) for one year. The electron and proton fluxes at the end of the year in three different L-shell regions were calculated considering only electrons and protons produced by decay of neutrons that leak out of the reactor. (D.C.W.)

37734 ELECTRON BOMBARDMENT OF THE ATMOSPHERE IN THE AURORAL ZONE. Evans, David Silas. Thesis, Berkeley, Calif., Univ. of California, 1962. 76p.

A number of scintillation-counter and pulse-height analyzer units were carried on balloons to 10 g cm^{-2} atmospheric depths over the auroral zone to investigate the electron bombardment of the atmosphere. This was done by measuring the x rays produced in the bremsstrahlung process from the electrons. With one exception, instances of electron precipitation were directly associated with mag-

netic disturbances caused by current systems in the ionosphere. However, no unique relationship between the two phenomena was determined. It was found that the presence of x rays at balloon altitudes resulting from electron bombardment of the atmosphere was always coincident in time with enhancements of the free electron density of the ionosphere, as indicated by increased ionospheric absorption of cosmic radio noise. An instance of a 100-second periodicity in the x ray flux at the scintillation counter was noted during a particularly intense electron bombardment. This is believed due to a time modulation of the primary electron flux rather than a motion in the position of the electron bombardment. The phenomena is similar to that of a pulsating aurora, but a direct association could not be made in this instance. (Dissertation Abstr.)

Low Temperature Physics

Refer also to abstracts 37210, 38044, and 38058.

37735 (N64-33921) INVESTIGATION OF CURRENT DEGRADATION PHENOMENON IN SUPERCONDUCTING SOLENOIDS. Summary Report, June 1963-May 1964. Salter, L. C. Jr. ([Atomics International, Canoga Park, Calif.]). Contract NAS8-5356. 46p. (NASA-CR-59369; AI-64-198). CFSTI, $2.00 cy, $0.50 mn.

Critical currents of unplated 0.025-cm-dia Nb-25%Zr wire are found to depend on the center-to-center spacing of the wires and on the number of layers of solenoid winding. For copper-plated 0.025-cm-dia Nb-Zr wires, solenoid critical currents are found to be given by $I = I_1 \log l + I_2$, where l is the wire length. Solenoid currents can be predicted to better than ±10% for both classes of wires. Experiments with various diameter Nb-33%Zr wires show that for copper-plated and unplated wires both solenoid and short sample critical currents decrease with increasing diameter. Degradation also increases with diameter. The effects of mechanical constraint and thermal environment are minor. The SN transition investigations show that the normal transition originates in the highest field region in the experimental solenoid and propagates predominantly by a process other than joule heating. (auth)

37736 (ORNL-TM-1173) EXPERIMENTAL SIMULATION OF LARGE, HIGH FIELD, SUPERCONDUCTING MAGNET OPERATION. First Quarterly Report, March 1-May 31, 1965. Gauster, W. F.; Coffey, D. L.; Ullmaier, H. A. (Oak Ridge National Lab., Tenn.). June 23, 1965. Contract W-7405-eng-26. 60p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

A series of new sample coils with 4- to 5-in. outside diameters for tests in the 6½-in., 80-kilogauss magnet was procured. Results of tests with several of these coils are reported. Preparations for experiments in a new 13-in. bore magnet facility are progressing. The extensive recent literature on the physics of type III superconductors is being studied. A brief digest of a selection of several important new results is presented along with some detailed new studies on similar subjects. (auth)

37737 (TID-21947) DETERMINATION OF ENERGY GAPS IN SUPERCONDUCTORS BY A NEW TECHNIQUE USING LOW RESISTANCE CONTACTS (thesis). Sullivan, Donald Barrett (Vanderbilt Univ., Nashville, Tenn.). May 1965. Contract AT(40-1)-1087. 65p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Measurements were carried out of the magnetic-field and temperature dependence of the energy gap in several hard superconductors. The temperature dependence is in excellent agreement with the predictions of BCS theory. It is believed that a direct measurement of the magnetic-field dependence of the energy gap in type II superconductors has not been previously reported. A model for very thin contacts between normal metals and superconductors, in reasonable agreement with the observations, is presented. The behavior of several unexplained junction characteristics reported in the literature is almost identical to those reported; the physical situation is sufficiently similar to suggest that the model proposed is applicable. (auth)

37738 ON THE EQUIVALENCE OF THE PHENOMENA OF THE MEISSNER EFFECT AND INFINITE CONDUCTIVITY IN SUPERCONDUCTORS. Evans, W. A. B.; Rickayzen, G. (Univ. of Liverpool). Ann. Phys. (N. Y.), 33: 275-307(June 17, 1965).

It is shown that under certain general conditions a metal will show either both infinite conductivity and a Meissner Effect in weak magnetic fields or neither. It is further shown that, provided phonon scattering and/or impurity scattering are present, both superconductors described by the BCS model and normal metals satisfy these conditions. Hence, it is concluded that superconductors possess both properties and normal metals neither. It is also concluded that the number of superconducting electrons defined by the Meissner Effect is equal in general to the number of electrons freely accelerated by an electric field. (auth)

37739 THE SUPERCONDUCTIVITY OF THE MONOCARBIDES OF TUNGSTEN AND MOLYBDENUM. Willens, R. H.; Buehler, E. (Bell Telephone Labs. Inc., Murray Hill, N. J.). Appl. Phys. Letters, 7: 25-6(July 1, 1965).

Samples of MoC and WC with fcc structure were obtained by rapid quenching from the melt. The structure was determined by x-ray diffraction, and the superconducting transition temperatures were measured. For MoC, the transition started at 14.3°K, while the fcc phase of WC with the largest lattice parameter had a transition temperature of at least 10.0°K. A sample of W_2C with the normal hexagonal structure was also obtained; its transition temperature was 3.6°K. (D.C.W.)

37740 GROSS DISCONTINUITIES IN THE MAGNETIZATION OF TYPE II SUPERCONDUCTORS. Carden, P. O. (Australian National Univ., Canberra). Australian J. Phys., 18: 257-63(June 1965).

Continuous records of magnetization as functions of field strength were obtained for specimens of type II superconductors. The records show gross discontinuities which are attributed to an instability mechanism involving macroscopic induced currents. The supposed mechanism is described and certain theoretical predictions are shown to agree reasonably with the observations. (auth)

37741 COHERENT MATTER WAVES DISCOVERED IN SUPERFLUID. Bell Lab. Record, 43: 187-9(May 1965).

Recent theories to explain superfluidity have proposed that the wave fields of pairs of electrons (in a superconductor) and of atoms (in a superfluid) are coherent; i.e., like light waves in a laser beam, they have the same frequency, amplitude, direction, and phase relation. To test this coherence aspect of superfluidity, an experiment was previously devised that is analogous to one on superconductivity. Two reservoirs of liquid He were filled to different levels or heads. Theory says that the matter waves in each reservoir oscillate at frequencies whose difference is proportional to the difference in heads. If the reservoirs are connected by a pinhole orifice, the superfluid tends to flow from the high-level reservoir, through the orifice, to the low-level reservoir, equalizing the head difference. A way was devised to observe whether this alternating current actually existed in the experiment. A small ultrasonic transducer was placed near the orifice in the low-head reservoir. The vibration of the transducer generated another alternating flow of liquid He through the orifice. The levels tended to stick at certain values of head difference as predicted by the theory. This is striking in that normally superfluid He flow, even through extremely fine holes, is hard to stop. This effect demonstrates directly that the wave fields in the two reservoirs are coupled in phase and therefore must be coherent. (TCO)

37742 SOME SUPERMAGNET DESIGN CONSIDERATIONS. Fields, T. H. (Argonne National Lab., Ill. and Northwestern Univ., Evanston, Ill.); Laverick, Charles. IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 362-6(June 1965).

The practicability of medium-sized superconducting

magnets was demonstrated by the performance of the ANL 67 kG seven inch magnet system. The design factors are summarized with special emphasis upon their implications for very large magnets. Various techniques for obtaining satisfactory current densities at a high level of stability and reliability are discussed. The clear implication of the results up to now is that very large supermagnets are indeed practical from a technical standpoint. The economic factors which must be carefully studied in order to establish the over-all practicality of large supermagnets are discussed. (auth)

37743 EFFECT OF STRESS ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF THIN FILMS OF TIN. Hall, P. M. (Bell Telephone Labs., Inc., Allentown, Penna.). J. Appl. Phys., 36: 2471-5(Aug. 1965).

Factors which affect the superconducting transition temperature (T_c) of thin tin films are of considerable importance in the design of thin film devices. An investigation of one such factor, the stress state of the film, is reported. Two approaches were used. First, the transition temperature was correlated with the differential thermal contraction between film and substrate. Six different types of glass were used for substrates, and the six films were evaporated simultaneously to ensure similar conditions of evaporation. Secondly, a substrate-bending technique was used to stress the film while holding it near its transition temperature. For both of these methods, shifts of the transition temperature greater than 0.1°K have been observed. However, it was found that agglomeration of the film can greatly reduce the dependence of the transition temperature on stresses transmitted to the film by the substrate. When agglomeration was negligible, both these approaches yielded a linear increase in T_c with tensile strain. Values for $d \ln T_c / d \ln v$ were obtained, where v is the volume of the tin film. The average values were +8.6 from the differential thermal contraction measurements, and +8.1 from the substrate bending measurements. These results are in reasonable agreement with the properties of bulk tin ($d \ln T_c / d \ln v = +7.5$). However, the films were able to withstand tensile stresses more than an order of magnitude greater than the elastic limit of bulk tin and still recover their original properties upon relaxation. (auth)

37744 NOTE ON THE SPIN AND CHARGE POLARIZATIONS AROUND AN IMPURITY IN A SUPERCONDUCTOR. Hurault, J. P. (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 26: 252-8(May 1965). (In French)

Existing calculations are improved for charge and spin polarizations induced around an impurity in a superconductor. The calculation could be tested by studies of interactions between magnetic impurities and the phonon spectrum, in materials of the Nb_3Sn group, with short coherence lengths. (auth)

37745 SURFACE SUPERCONDUCTIVITY. Burger, J. P. (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 26: 263-7(May 1965). (In French)

Surface superconductivity, predicted by de Gennes and Saint-James, explains most of the experimental observations often attributed to the metallurgical conditions (defects, strain, etc...) of the superconductors investigated. Good quantitative agreement reinforces this theory. (auth)

37746 VORTEX EXCITATIONS IN SUPERFLUID HELIUM. Pincus, P.; Shapiro, K. A. (Univ. of California, Los Angeles). Phys. Rev. Letters, 15: 103-4 (July 19, 1965).

The ideas on vortex excitations are extended to transverse modes. The method of calculation starts from an expression that maintains irrotational flow except at the vortex singularities. (J.F.P.)

37747 ENERGY OF NEGATIVE IONS IN LIQUID HELIUM BY PHOTOELECTRIC INJECTION. Woolf, Michael A. (Bell Telephone Labs., Murray Hill, N. J.); Rayfield, G. W. Phys. Rev. Letters, 15: 235-7(Aug. 9, 1965).

A simple experiment is described which uses the photoelectric effect to measure the energy required to inject an electron into liquid helium. The work function of a photosensitive surface is measured first in vacuum. The surface is then submerged in liquid helium and the work function is again measured. Subtracting the work function measured in vacuum from that measured in helium, the injection energy is obtained. It is expected that most of the injected electrons enter the liquid rapidly enough so that the helium atoms are essentially undisturbed. The electron is then untrapped initially and its energy can be estimated. (J.F.P.)

37748 BINDING OF POSITIVE-ION COMPLEXES TO VORTEX RINGS IN LIQUID-HELIUM II. Cade, Andrew G. (Columbia Univ., New York). Phys. Rev. Letters, 15: 238-9(Aug. 9, 1965).

A measurement of the energy of binding of positive-ion complexes (referred to as ions) to vortex rings in liquid helium II at temperatures near 0.5°K is presented. It is assumed that the ion is bound to a vortex ring with some potential which depends only on the distance r, between the ion and the vortex core. Analysis of these data gives $eW = 1.03 \pm 0.1$), where W is the binding energy, and $r_m = (5.5 \pm 1)$Å. By reversing polarities of all the d-c potential used in the experiment, negatively-charged vortex rings may be observed. At 0.5K°, high-voltage pulses <1.8 kv, 6.5 μ sec^2, produce no effect on this current. (J.F.P.)

37749 FLUX PUMPS AND SUPERCONDUCTING SOLENOIDS. Van Beelen, H.; Arnold, A. J. P. T.; Sypkens, H. A.; Van Braam Houckgeest, J. P.; DeBruyn Ouboter, R.; Beenakker, J. J. M.; Taconis, K. W. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 31: 413-43(Apr. 1965).

A review is given of the various types of flux pumps and current generators which have been developed so far in several laboratories. Experiments carried out with wire and foil solenoids, fed by the flux pump developed in the Kamerlingh Onnes Laboratory, are discussed. It is shown that 50-kgauss, many-strand wire solenoids with a central core diameter of the order of a few centimeters, can at the present time be fed with this flux pump in a competitive way compared to feeding them with the ordinary current supplies from outside the liquid helium dewar. Attention is paid to the unavoidable heat dissipation in this type of pump. The experiments with foil-solenoids show a disappointingly low current-carrying capacity of the Nb-Zr foil in comparison with that of wires of the same type of material. An explanation of the results on the basis of the critical-state theory is proposed. From the pumping characteristics it is shown that starting off at a certain critical field, a gradual change of self-induction of the coil occurs. (auth)

37750 FLUX JUMPS IN A HARD SUPERCONDUCTOR. Goedemoed, S. H.; Van Kolmeschate, C.; Metselaar, J. W.; De Klerk, D. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 31: 573-84(Apr. 1965).

The occurrence of flux jumps in superconducting niobium has been derived from measurements of the susceptibility, magnetization and temperature. The field and temperature regions in which they occur were determined, and the amounts of heat involved in the jumps could be estimated. A hypothesis concerning the propagation mechanism of flux jumps through a bundle of wires is put forward. (auth)

37751 QUASI-SUPERCONDUCTIVE TRANSITIONS IN STRONG MAGNETIC FIELDS. Froehlich, H.; Terreaux, C. (Univ. of Liverpool). Proc. Phys. Soc. (London), 86: 233-6(July 1965).

It is predicted that superconducting semimetals or semiconductors should have a further phase transition in very strong magnetic fields, characterized by vanishing electric resistivity in the direction of the magnetic field. (auth)

37752 ON THE MECHANISM OF SUPERCONDUCTIVITY IN ALLOYS. Geilikman, B. T. Zh. Eksperim. i Teor. Fiz., 48: 1194-7(Apr. 1965). (In Russian)

A possible mechanism for superconductivity in ordinary three-dimensional systems, analogous to the mechanism suggested by W. A. Little (Phys. Rev., 134A: 1416 (1964)) for one-dimensional systems is considered. By evaluating the exchange integral and assuming that screen-

ing is taken into account, the conditions are derived under which attraction forces can arise between various electrons in pure metals of transition groups and in alloys, and it is indicated that the mechanism can not be effective in pure metals, but can occur in ordered alloys of transition-group metals with such non-metals as C, N, Si, and S, which have an unfilled shell whose electrons are sufficiently strongly bound to the atom and therefore do not "collectivize" in the alloy. (ATD)

37753 ANOMALIES OF THE SUPERCONDUCTING TRANSITION TEMPERATURE UNDER PRESSURE. Makarov, V. I.; Baryakhtar, V. G. (Inst. of Physics and Tech., Kiev). Zh. Eksperim. i Teor. Fiz., 48: 1717-22(June 1965). (In Russian)

It is shown that a change in the topology of the Fermi surface in a superconductor induced by external pressure results in a nonlinear variation of the superconducting transition temperature T_k with pressure. The relative change of T_k is the order of the square root of the ratio of the Debye temperature ω to the Fermi energy ϵ_0. (auth)

37754 BOUNDARY CONDITIONS FOR THE SUPERCONDUCTIVITY EQUATIONS AT NEAR-CRITICAL TEMPERATURES. Zaitsev, R. O. Zh. Eksperim. i Teor. Fiz., 48: 1759-71(June 1965). (In Russian)

Effective boundary conditions on the interface between superconducting and normal metals are derived. All possible cases leading to second-order differential equations are considered. It is shown that the boundary conditions obtained in the absence of a magnetic field can easily be extended to the case of a stationary magnetic field directed along the interface. Those results which can be compared with the experimental data are found to be in satisfactory agreement with them. (auth)

37755 SPIN-ORBIT INTERACTION WITH THE LATTICE AND THE KNIGHT SHIFT IN SUPERCONDUCTORS. Gorkov, L. P. (Dept. of Chemical Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 48: 1772-5(June 1965). (In Russian)

It is shown that the spin-orbit interaction with the lattice can not lead to a large value of the Knight shift in a superconductor. In this connection, attention is drawn to the fact that if the shift is independent of the sample size and is $\frac{2}{3}$, as in mercury, then it can be accepted as proven that Cooper pairing occurs in the triplet state. (auth)

37756 CELL MODEL FOR LIQUID HYDROGEN. Reed, Robert Dale. Thesis, Tempe, Ariz., Arizona State Univ., 1964. 53p.

The classical cell model of Lennard-Jones and Devonshire is modified to include quantum effects and is applied to liquid hydrogen. The potential energy of liquid hydrogen is assumed to result from additive contributions of pairs of molecules and the intermolecular potential is assumed to be given by the Lennard-Jones 6-12 potential. The classical integration over phase space is replaced by a sum over the energy levels of the molecule in a cell. The effects of the first three neighboring shells are taken into account and the energy levels are determined by the WKBJ method. The thermodynamic properties of liquid hydrogen are calculated for the region of high densities and low temperatures where the cell model is most valid. The absolute values for these properties are only fairly satisfactory. However, the values for the quantum corrections to these properties are in good agreement with experimental values. (Dissertation Abstr.)

37757 PARAMAGNETIC IMPURITIES IN SUPERCONDUCTORS. Fredkin, D. R.; Suhl, H. (Univ. of California, La Jolla). pp 9-10 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The experimental and theoretical status of paramagnetic impurities in superconductors is reviewed. A new dynamical theory is proposed and is used to give a simple explanation of gapless superconductivity. The effect of paramagnetic impurities on the Josephson effect is discussed. (auth)

Neutron Physics

See also REACTOR TECHNOLOGY — Criticality Studies.

37758 (BNL-9243) LEAST SQUARES ANALYSIS OF NEUTRON RESONANCE PARAMETERS. Bhat, M. R.; Chrien, R. E. (Brookhaven National Lab., Upton, N. Y.). May 1965. Contract AT-30-2-GEN-16. 8p. (CONF-650705-17). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Conference on the Study of Nuclear Structure with Neutrons, Antwerp.

The dependence of the area above a slow neutron transmission dip on the sample thickness and the Breit-Wigner parameters has long been known and exploited to deduce the level parameters. When more than two sample thicknesses are utilized, however, the calculations of the "best" parameters, their errors, and their correlations are quite involved. The problem is best solved by using a generalized least-squares fitting technique with a large, fast digital computer. This approach is presented. (M.O.W.)

37759 (BNWL-35) GAMTEC II—A CODE FOR GENERATING CONSISTENT MULTIGROUP CONSTANTS UTILIZED IN DIFFUSION AND TRANSPORT THEORY CALCULATIONS. Carter, L. L.; Richey, C. R.; Hughey, C. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1965. Contract AT(45-1)-1830. 78p. Dep. (mn); $3.00(cy), 2(mn) CFSTI.

The GAMTEC II code generates multigroup constants in the energy range from 0 to 10 Mev for either homogeneous mixtures or heterogeneous arrays of cylindrical fuel elements. The thermal group constants are averages over either a Wigner-Wilkins light moderator spectrum, a Wilkins heavy moderator spectrum, or a Maxwellian distribution. For heterogeneous arrays, the spatial thermal flux is calculated by the P_3 approximation. For epithermal energies, the slowing down distribution is described by either a P_1 or B_1 approximation to the Boltzmann equation. Resonance absorption is calculated by the Adler-Nordheim method. Fast fission corrections are calculated by an n-flight collision probability technique. Multigroup constants are punched on cards in both HFN (diffusion theory) and DTF (S_n transport theory) formats. (auth)

37760 (KAPL-M-6186(Rev.II)) KARE INPUT. Fletcher, J. L. (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 1964. Revision I, Nov. 1964. Revision II, May 1965. Contract W-31-109-eng-52. 90p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

Revision sheets for the KARE neutron-diffusion program input manual are presented. (T.F.H.)

37761 (KAPL-M-6471) THE SLOWING DOWN SOURCE INTO THERMAL FLUX CALCULATIONS IS NOT QUITE THE SLOWING DOWN DENSITY. Federighi, F. D.; Goldman, D. T. (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 16, 1965. Contract W-31-109-eng-52. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A technique is proposed for including the effect of neutrons scattered up in energy from the thermal range to epithermal energies in neutron thermalization calculations. This is a correction to the approximation that the neutron source into the thermal region is the slowing down density past the cut-off energy in the epithermal region, with no provision for handling the upscattering of neutrons due to the chemical motion of the scatterers. Formulas are presented based upon the approximation of the scattering from a free gas of mass M at an effective temperature $\bar{T}$. For a mass M = 1 target especially simple results apply. (auth)

37762 (KFK-301) A REVIEW OF PULSED NEUTRON EXPERIMENTS ON NON-MULTIPLYING MEDIA. Beckurts, K. H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). May 1965. 44p. (SM-62/1; CONF-650504-38). Dep. mn.

From Symposium on Pulsed Neutron Methods, Karlsruhe, Germany.

Experiments on the behavior of neutrons in water and

ice, various organic moderators, and graphite, using pulsed-source techniques, are reviewed. Decay measurements on thermalized neutron fields are discussed. Transient phenomena in moderators—experiments measuring slowdown and thermalization times—are considered, and quasi-asymptotic decay of monoenergetic neutron fluxes in heavy scattering substances is dealt with. 74 references. (M.J.T.)

37763 (ORNL-3778(p.89-92)) RESONANCE PARAMETERS FOR NEUTRON SCATTERING FROM ^{208}Pb. Fowler, J. L. (Oak Ridge National Lab., Tenn.).

Results are presented of a partial-wave phase-shift analysis of neutron scattering from ^{208}Pb. Reduced widths of resonances are discussed in terms of intermediate states. (auth)

37764 (ORNL-RSIC-4) SOME CALCULATIONS OF THE FAST-NEUTRON DISTRIBUTION IN ORDINARY CONCRETE FROM POINT AND PLANE ISOTROPIC FISSION SOURCES. Trubey, D. K.; Emmett, M. B. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 63p. Free (ORNL)

Fast-neutron dose rates and energy distributions due to point and plane isotropic fission sources in an infinite medium of ordinary concrete were calculated by the moments-method code RENUPAK. As a check on the method, one Monte Carlo calculation was performed which yielded results in good agreement with those for the corresponding RENUPAK case. The effects of varying the concrete composition, especially the hydrogen content, and the lower energy cutoff were examined for several cases and found to be significant. Detailed tables of the energy spectra are given at lethargy steps of 0.1 from 0.001 to 18 Mev. (auth)

37765 (RPI-328-22) THE EFFECTS OF COHERENT SCATTERING ON THE THERMALIZATION OF NEUTRONS IN BERYLLIUM. Fullwood, R. R.; Gaerttner, E. R.; Slovacek (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science). [1964]. Contract AT(30-3)-328. 6p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

In attempting to study the approach to an asymptotic spectrum in crystalline material, a series of center spectrum measurements on beryllium metal for buckling values of 0.12, 0.075, 0.026, and 0.013/cm^2 and a surface measurement for the buckling 0.026/cm^2 were performed. These measurements were performed using the pulsed-Linac-phased-neutron chopper technique to allow sampling of the neutron spectrum at the desired time. These data cover the range from one mean-lifetime to six for two buckling values. The term mean-lifetime is not uniquely defined in a crystalline material but is taken to be the result of a die-away measurement. (M.O.W.)

37766 (RPI-328-23) MEASUREMENT AND ANALYSIS OF TIME-DEPENDENT NEUTRON SPECTRA IN D_2O. Kryter, R. C.; Calame, G. P.; Fullwood, R. R.; Gaerttner, E. R. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science). [1964]. Contract AT(30-3)-328. 7p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

Previous theoretical studies have shown that the spectrum of neutrons present in an infinite, homogeneous system at relatively early times following the introduction of a pulse of fast neutrons is sensitive to scattering kernel details. Utilizing these findings, a series of time-dependent spectrum measurements were carried out using a 50 cm cube of 99.76 mole % heavy water maintained at 43.3°C as the spectrum source. The experimental technique involves a phased neutron chopper in conjunction with a pulsed linear electron accelerator. (M.O.W.)

37767 (WAPD-T-1788) IMPROVED P_3 VACUUM BOUNDARY CONDITIONS AND THEIR USE IN PULSE CALCULATIONS. Schmidt, E.; Gelbard, E. M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1965. Contract AT(11-1)-Gen-14. 13p. (CONF-650602-25) Dep.(mn); $1.00(cy), 1(mn) CFSTI

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

Calculations of neutron extrapolation lengths in pulsed water systems in the P_3 approximation are carried out using the Radkowsky and Nelkin kernels, and the results with both these kernels are found to disagree with experimental results on slab and spherical systems. Adjustments in the boundary conditions for the P_3 calculations are attempted, in order to improve the agreement between calculation and experiment. It is found, however, that although the P_3 calculations generally yield self-consistent results, the discrepancy between these results and experiment remains. (T.F.H.)

37768 (WCAP-3269-34) THEORETICAL CALCULATIONS OF INELASTIC SCATTERING MATRICES FOR MULTIGROUP REACTOR ANALYSIS. Bhalla, C. P. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Sept. 1964. Contract AT(30-1)-3269. 63p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A calculational procedure for obtaining the inelastic scattering probabilities, which are required for MUFT-4, a multigroup fast neutron spectrum code, is described. The relevant theoretical considerations are summarized. The formulation of Hauser and Feshback is used when known nuclear levels can be excited. In all other cases, the statistical model is recommended. To elucidate the procedure an illustration is given for ^{56}Fe. In addition, general inelastic scattering probabilities are presented as a function of nuclear temperatures, and a critical discussion of the theoretical developments in the statistical model is given. (auth)

37769 ON THE SHAPE OF THE SPECTRUM OF NEUTRONS SLOWING DOWN IN ABSORBING MEDIA. Avaev, V. N. At. Energ. (USSR), 18: 584-8(June 1965).

An approximation technique for resolving kinetic equations for infinite homogeneous media with uniformly distributed sources at Σ_s = const. and $\Sigma_c \approx 1/\sqrt{E}$ was studied. A simple analytical expression was derived for spectrum shape of slowing down neutrons in absorbing media. The calculated spectrum shape was compared to the experimentally derived spectrum. The results confirmed the applicability of the derived expression for media with a maximum magnitude ratio $\Sigma_c/\xi\Sigma_s = 10$. (R.V.J.)

37770 MEASUREMENTS OF NEUTRON SPECTRA IN NICKEL, IRON, AND STAINLESS STEEL. Bondarenko, I. I.; Liforov, V. G.; Morozov, V. N.; Nikolaev, M. N.; Parfenov, V. A.; Semenov, V. A. At. Energ. (USSR), 18: 593-600(June 1965).

Neutron spectra in various thicknesses of nickel, iron, and stainless steel prisms were measured by the time-of-flight method in a pulsed fast IBR reactor with a resolving power 0.04 μ sec/m. The measured spectra revealed the presence of the fine structure produced by resonance character of cross sections of the investigated media. The experimental neutron cross sections compared with the results of calculations using multigroup system of constants taking into account cross section, self screening showed some discrepancies. Diagrams of neutron leakage from 31, 52, and 77 cm thick nickel prisms, 30 and 49 cm iron prisms, and 30 and 48 cm stainless steel prisms are analyzed. (R.V.J.)

37771 EFFECTIVE METHOD FOR RESOLVING TWO-DIMENSIONAL DIFFUSION EQUATION FOR TETRAGONAL AND HEXAGONAL SHAPE CELLS. Marchuk, G. I.; Kochergin, V. P. At. Energ. (USSR), 18: 638-40(June 1965).

A method is suggested for resolving a two-dimensional diffusion equation for tetragonal and hexagonal shaped cells described by the two-dimensional one-group diffusion equation with a constant moderating source in a polar coordinate system. Considering only real shape cells (with intrinsic circular symmetry) the two-dimensional equation was reduced to a series of one-dimensional diffusion equations and resolved by a finite-difference formula. The results of calculations were varified by successful interchange of real shape cells by Wigner-Seitz equivalent cells. However, it was also shown that the use of the Wigner-Seitz equivalent cell may result in some errors. This is illustrated in a table exhibiting the mean (according to the cell) neutron

absorption cross sections in various approximations when the shielding blocks are close to each other (the maximum cell shape effect). The table shows that the consideration of cell geometry and kinetic effects result in reduced mean neutron absorption cross sections. For the hexagonal shape cells these effects are identical but for the tetragonal cell the shape effect becomes even larger than the kinetic effect. (R.V.J.)

37772 A NEW ANALYTICAL SOLUTION OF THE ENERGY-DEPENDENT BOLTZMANN EQUATION. Papmehl, Nikolai (EURATOM, Ispra, Italy). Nucl. Sci. Eng., 22: 451-4(1965).

Starting from the observation that exponentials of lethargy are just eigenfunctions of the elastic-scattering-energy transfer operator, a Fourier transform with respect to lethargy is applied to the energy-dependent Boltzmann equation. For constant cross sections and isotropic scattering in the center of mass system (but arbitrary anisotropy in the laboratory system), this leads to a "one-velocity" transport equation with a complex number of secondaries. Hence, if the method of Case is now to be applied it has to be extended to cover this situation. For an infinite medium, however, the solution may readily be obtained by a Fourier transform with respect to the space coordinate. Thus, the exact result is a double Fourier inversion integral, which can be calculated numerically. It is shown that well-known solutions can be obtained by an approximate evaluation of this integral. (auth)

37773 ON TRANSIENT PHENOMENA IN THERMALIZATION. Leonard, Anthony (Rand Corp., Santa Monica, Calif.). Nucl. Sci. Eng., 22: 489-90(1965).

In connection with the measurement of λ_0 and L in exponential thermal-neutron experiments, it was recently proved (Corngold, Nucl. Sci. Eng., 19: 80(1964)) that all the spatial decay constants vanish for a sufficiently high concentration of absorber. It is shown that for a large class of scattering models (those in which the total cross section, $\Sigma(v)$, tends to a constant as $v \to \infty$), the proof given is not valid. In fact, if the approach of $\Sigma(v)$ to a constant is fast enough, the theorem is false. (D.C.W.)

37774 MEASURED AND PREDICTED NEUTRON FLUXES IN, AND LEAKAGE THROUGH, A CONFIGURATION OF PERFORATED Fe PLATES IN D_2O. Aalto, E. (AB Atomenergi, Stockholm). Nucl. Struct. Eng., 2: 142-50(July 1965).

Detailed neutron flux measurements were performed in a 48-cm thick configuration of thin regions of Fe and D_2O (30% of total thickness Fe) both when the Fe regions are massive and when they are penetrated by 15-cm-dia D_2O channels. It was found that the total leakage of neutrons through the configuration was increased by 25% in the latter case. It is shown that this increase and the detailed flux distribution on a duct axis can be satisfactorily predicted by a one-dimensional shielding code when the duct is calculated as a pure D_2O layer and a radial buckling term is used for the < 1-ev neutrons when penetrating the Fe regions. Another calculation through the massive part of Fe is to be performed in the usual way. It is believed that this 2-component method is usable in a wider range of similar configurations. A calculation with regions where the Fe and the D_2O ducts were homogenized into a single material overestimated the increase in leakage, and the relative error was greater than that in the 2-component calculation. (auth)

37775 POLARIZATION EFFECTS IN NEUTRON DIFFUSION. Kazachenkov, Yu. N. Yadern. Fiz., 1: 763-75(May 1965). (In Russian)

Equations taking into account the neutron polarization are written down and solved in the one-group diffusion approximation. It is shown that except for the case of a large scattering anisotropy the role of the initial polarization decreases significantly as the neutrons are propagated. When polarized neutrons are incident on a medium, their flux may not be directed along the density gradient. In the forward scattering, most of the neutrons have the same polarization as before the scattering. The asymptotic form of the polarization flux far from the boundary is found. (auth)

37776 THE USE OF RANDOM SAMPLING AND MULTIPARAMETER ANALYSIS FOR TIME DEPENDENT SPECTRA MEASUREMENTS. Nicholson, K. P.; Poole, M. J. (United Kingdom Atomic Energy Research Establishment, Harwell, Berks, Eng.). pp 96-9 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A problem in neutron thermalization required the measurement of the thermal neutron spectrum in a graphite block at a definite time after the injection of a pulse of fast neutrons. One method for this is to synchronize a neutron chopper to the pulsed source (electron linac). An alternative that has been used is presented in which the chopper runs asynchronously and delay times from pulse-to-chopper opening and from chopper opening to detector signal are written on magnetic tape as pairs of binary numbers. All the required information can then be obtained by subsequent analysis of the data stored on the tape. It is demonstrated that this method eliminates the need for monitors and leads to a high degree of automation in the experiment. The method is clearly applicable in other fields. (auth)

37777 COMPLETE NUMERICAL ANALYSIS OF NEUTRON RESONANCES IN TRANSMISSION EXPERIMENTS. Bianchi, G.; Corge, C. R. (Centre d'Etudes Nucleaires, Saclay, France). pp 517-24 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

Numerical analysis of transmission resonances induced by s wave neutron in time-of-flight experiments can be achieved in a fairly automatic way on an IBM 7094 computer. The involved computations consist of four main steps. (i) Experimental raw data are processed to determine the resonant transmission. The relevant program carries out calculations to estimate the dead time correction and to determine the background spectrum. It can cope with 65,000 channels. Results are plotted on graphs. (ii) Any method of analysis reduces to the solution of an over determined system of equations. In these equations appear experimental quantities. It is therefore necessary to derive their values from the above experimental mission. A rough estimation of the parameters is made. (iii) The over determined system is solved by means of a least square method. Programs have been written for each type of involved theoretical function depending on the analysis method. But, whatever the method is, Doppler broadening and resolution effect are taken into account. The fundamental total cross-section is described by the single level Breit-Wigner formula with the interference term. All programs relative to the partial area method, the shape analysis and the so-called method at depth f of the dip are discussed. All of them can consider several sample thicknesses simultaneously. The two first can analyze transmission data for several resonances at once. (iv) Graphical control of the results is performed. All the methods will be gathered in a single code. (auth)

37778 MAGGIE, A VERSATILE MONTE CARLO PROGRAM FOR MULTIPLE SCATTER CORRECTIONS. Parker, J. B.; Towle, J. H.; Sams, D.; Gilboy, W. B.; Purnell, A. D.; Stevens, H. J. (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). pp 525-32 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

Measurements of differential cross sections for elastic and inelastic scattering of fast neutrons are generally made using a time-of-flight detector at about one meter from a cylindrical sample. A Monte Carlo program has been developed to correct the results for the effects of flux attenuation, multiple scattering, and the angular spread of the incident neutrons. Owing to the small acceptance angle of the detector, a direct Monte Carlo simulation of the experiment would be grossly inefficient. For this reason a completely different approach is used based on expectation values, in which all neutron histories contribute to the computed result. The basis of the method is to compute

at each collision the chance of a neutron emerging in the direction of the detector, for each of a sufficient number of detector positions. By accumulating these chances or scores, accurate corrections may be made using relatively few neutron histories. An important feature is the classification of the scores into energy cells as well as collision types. This permits correction for the effect of multiple scattering in the observed energy or time-of-flight spectra. Examples of the application of the program to various experiments are given. (auth)

37779 RESONANCE ABSORPTION OF NEUTRONS IN MIXTURES OF THORIUM-232 AND URANIUM-238: AN INVESTIGATION OF INTERFERENCE BETWEEN ABSORBERS. Foell, Wesley Kay. Thesis, Stanford, Calif., Stanford Univ., 1964. 190p.

Resonance integral measurements, using a static reactivity technique in the Advanced Reactivity Measurement Facility (ARMF-II) at the National Reactor Testing Station, were performed on cylindrical compacted power samples containing the absorber (or absorbers) and a lead dioxide diluent. The experimental results for uranium-238 dioxide/lead dioxide samples were in good agreement with the results predicted with the aid of Nordheim's treatment. Because the resonance parameters of uranium-238 are well established, this was interpreted to substantiate the adequacy of the experimental techniques. The concept of interference was formulated and defined as the effect on the resonance integral caused by the lack of complete flux recovery between resonances. The definition included only those effects due to the presence in a system of an additional resonance or resonances; effects predictable by conventional theory were not considered to be interference. Interference was predicted in a series of uranium-238/thorium-232 mixtures by means of multiresonance solutions of the first-flight coupled equations; as many as three close-lying resonances were treated simultaneously with a modification of the Nordheim treatment. The results, based on a calculation of interference in several of the most prominent resonances, predicted an interference of approximately 1.3 percent in the samples of highest absorber concentration. Interference was measured in the uranium-238/thorium-232 mixtures. The results indicated approximately 3.5 percent interference in the samples of highest absorber concentrations. Because the interference was small, it was difficult to quantitatively confirm the adequacy of the multiresonance calculation technique. (Dissertation Abstr.)

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Refer also to abstracts 36428, 36452, 36892, 37242, 37292, 37612, and 38228.

37780 (BAW-3125-4) NONUNIFORM TEMPERATURE EFFECTS ON THORIUM RESONANCE ABSORPTION. Final Report. Pettus, W. G.; Baldwin, M. N. (Babcock and Wilcox Co., Lynchburg, Va. Critical Experiment Lab.). Apr. 1965. Contract AT(30-1)-3125. 56p. (EURAEC-1409) Dep.(mn); $3.00(cy), 2(mn) CFSTI

Work Performed under United States-Euratom Joint Research and Development Program.

The experimental measurement of the Doppler effect in neutron resonance capture for samples having a nonuniform temperature distribution is discussed. These measurements were made on thorium and thorium dioxide rods of approximately one centimeter radius. An activation technique was used, and the samples were exposed in a cadmium thimble at the center of a pool research reactor. The activated samples were dissolved, and the ^{233}Pa was separated out and gamma-counted. The Doppler coefficients for identical samples were determined with an axial heat source and with a peripheral heat source. In the axially heated cases, the heat was removed from the surface by a water-cooled jacket, and an approximately logarithmic radial temperature profile was obtained. For these cases, measurements were made with radial temperature drops ranging up to 185°C for the metal samples and up to 1000°C for the oxide samples. In the peripherally heated cases, the temperature was uniform through the samples, and measurements were made with the temperature ranging up to about 350°C for both metal and oxide samples. The results show that the Doppler coefficient as a function of the average sample temperature is essentially the same for both axial and peripheral heating over the temperature range investigated. (auth)

37781 (BNL-927) OPTICAL MODEL ANALYSIS OF ELASTIC AND INELASTIC SCATTERING OF NEUTRONS BY ALUMINUM IN THE Mev REGION. Moore, S. O. (Brookhaven National Lab., Upton, N. Y.). June 1965. Contract AT(30-2)-Gen-16. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Elastic and inelastic scattering of neutrons on ^{27}Al, a light-mass deformed nucleus, was studied for neutrons from 1 to 5 Mev, using a spherical optical-model potential. The Hauser-Feshbach formalism with transmission coefficients determined for a complex, spin-dependent, diffuse-edge potential with surface absorption is used in the calculation. Selection of the experimental data and handling of the data are discussed. Total and differential elastic cross section data were first considered, and best-fit parameters were found and used to calculate the inelastic scattering cross sections and to obtain parameters consistent with both elastic and inelastic scattering data. Results are given for total, differential elastic and inelastic, and integral inelastic cross sections. (M.J.T.)

37782 (BNWL-97) THEORY-EXPERIMENT COMPARISON OF Pu^{240} RESONANCE ABSORPTION. Heeb, C. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 24, 1965. Contract AT(45-1)-1830. 27p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A comparison of the theoretical and experimental results of resonance absorption in plutonium-240 is presented. It is concluded that theoretical methods do not conflict with experimental results. (M.O.W.)

37783 (CALT-63-16) MAGNETIC DIPOLE TRANSITION RATES IN DEFORMED ODD-A NUCLEI. de Boer, J.; Symons, G. D. (California Inst. of Tech., Pasadena, Calif.). [1964]. Contract AT(04-3)-41. 4p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The ground state rotational bands of ^{153}Eu, ^{159}Tb, ^{163}Dy, ^{165}Ho, ^{167}Er, ^{175}Lu, and ^{177}Hf are studied by multiple Coulomb excitation. The transition energies and the gamma ray branching ratios for the decays of the second, third, and fourth excited rotational levels were determined. Assuming the theoretical values for the E2 transition rates, the values of B(M1) can be determined from the branching ratios. There is an indication that, for the nuclei investigated, the absolute value of the rotational parameter $|g_K - g_R|$ increases with increasing angular momentum. (auth)

37784 (CONF-650524-2) EVALUATION OF NEUTRON CROSS SECTIONS AT THE KNOLLS ATOMIC POWER LABORATORY. Francis, N. C.; Lubitz, C. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 19, 1965. Contract W-31-109-eng-52. 3p. Dep.(mn); $1.00(cy), 1(mn) CFSTI

From European Nuclear Energy Agency and Atomic Energy Commission Seminar, Upton, N. Y.

Fine-mesh libraries of neutron cross section data are discussed. The names and purposes of the various computer programs which are used in the data evaluation processes are given. (M.O.W.)

37785 (CONF-650602-26) INTEGRAL MEASUREMENTS OF ALPHA FOR U-235 IN THE EPITHERMAL REGION. Esch, L. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract W-31-109-eng-52. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

In an effort to shed additional light on the discrepancy between direct integral measurements of the epithermal capture-to-fission ratio of ^{235}U and the value of that quantity obtained by integration of energy dependent data, new

integral measurements are presented. Eight samples of ^{238}U were irradiated. Each sample consisted of approximately 1 mg of ^{235}U, in the form of U_3O_8, mixed with 70 mg MgO as a dry powder and sealed under a vacuum in a quartz ampoule. The dilution is such that self-shielding of the uranium is very small. A detailed description of the experimental procedure is included. (M.O.W.)

37786 (IDO-17089) SLOW NEUTRON SCATTERING STUDIES OF LIQUID AND SOLID ARGON. Randolph, P. D. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). May 1965. Contract AT(10-1)-205. 22p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Measurements with the Materials Testing Reactor phased-chopper velocity selector were made of the slow neutron inelastic scattering from samples of liquid (88.7°K) and solid (82°K) argon. These measurements were made at incident neutron energies of 20, 40, and 100 Mev for the liquid samples and at 20, 40, and 60 Mev for the solid samples, and spanned a wave vector change κ from 2 to 14 $Å^{-1}$ for the liquid and from 1 to 11 $Å^{-1}$ for the solid. The scattering laws for the two phases show distinct momentum dependent coherent inelastic scattering such as has been observed previously in liquid Na and in polycrystalline Be and Al. A frequency spectrum of the normal modes of vibration were obtained for the solid using the methods of Egelstaff. The spectrum, corrected for multiple phonon excitations, shows two small maxima at 4.7 and 6.9 Mev, and has more low frequency modes than either a Debye spectrum or a second nearest neighbor, Born-von Karman spectrum. (auth)

37787 (IFA-CR-52) ON THE MEASUREMENT OF COULOMB SCATTERING IN THE PRESENCE OF TRACK DISTORTION AND SPURIOUS SCATTERING. Friedlaender, E. M.; Marcu, M.; Friedlaender, J. (Institutul de Fizica Atomica, Academia R. P. R., Bucharest). Mar. 1965. 47p. Dep.(mn).

An analysis is made of the statistical features of tracks scattered in nuclear emulsions with special regard to correlations between adjoining sagittae. A procedure is worked out for eliminating spurious scattering in the presence of magnetic and distortion curvature of the track, valid also for dipping tracks. This procedure has been checked with satisfactory results on 5000 readings taken on pion and proton beams in three different stacks. A spurious component was detected among the large single scatters rejected by the usual cut-off criteria. This implies a possibly important contribution of such sharp spurious breaks to the accepted sagittae and/or to shadow scattering, too. (auth)

37788 (INR-591/IA/PL) EVAPORATION OF NEUTRONS FROM STRONGLY EXCITED CLOSED SHELL $f_{\frac{7}{2}}$ NUCLEI IN INELASTIC NEUTRON SCATTERING. Koralewski, Jozef; Kozlowski, Tadeusz; Moroz, Zbigniew; Wojtkowska, Jolanta (Institute of Nuclear Research, Warsaw (Poland)). Dec. 1964. 26p. Dep.

Continuous spectra of neutrons inelastically scattered on ^{51}V, ^{52}Cr, and ^{58}Ni were measured with a time-of-flight spectrometer at an incident energy of 14.1 Mev. The spectra were observed above the maximum energy of neutrons from the (n,2n) reaction. From these spectra, the level density parameters T and a were calculated. The results of investigations and comparisons with other measurements are as follows: (a) the dominant reaction mechanism in the measured energy range is the evaporation of neutrons, (b) the Fermi gas model gives a good approximation for nuclei with closed shell, (c) there is evidence that the effect of pairing is insignificant at the studied excitation energy, and (d) the optical model reaction cross section seems to be a good expression for the inverse reaction cross section. (auth)

37789 (IS-T-12) ANGULAR AND ENERGY DISTRIBUTIONS OF PHOTOPROTONS FROM COBALT-59 (thesis). Juhala, Roland Edwin (Ames Lab., Iowa State Univ. of Science and Tech.). May 1965. Contract W-7405-eng-82. 86p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The energy and angular distributions of photoprotons produced from a ½ mile cobalt-59 target were determined using 30-, 45-, and 65-Mev bremsstrahlung. A relative calculation of the integrated cross section from 30 to 65 Mev was done by the Leiss-Penfold method. Nuclear emulsions were used to detect the protons. The 30-Mev bremsstrahlung angular distribution from 20 to 160° indicated a peak at about 70° with respect to the incident beam direction, a minimum at 130°, and a rising tail from 130 to 160°. The proton energies which primarily contribute to this tail are in the 3.0- to 6.5-Mev region. The 65-Mev bremsstrahlung angular distribution showed only a forward peaking at about 65°, although a breakdown of the data into 2-Mev intervals indicates a rising tail in the 5.0- to 7.0-Mev region. The relative integrated cross-section calculation was done assuming the shape of the cross-section curve between 15.5 and 23.5 Mev as that obtained by Halpern and Mann. Since no data exist for the cross section below 15.5 Mev, it was assumed to decay down to threshold (7.3 Mev) as $(1/E)^2$. The absolute integrated cross section from threshold to 30 Mev was determined to be 0.278 ± 0.130 Mev-barns. Relative to this, the integrated cross sections between 30 and 45 Mev and between 45 and 65 Mev were found to be 0.122 ± 0.061 and 0.313 ± 0.063 Mev-barns respectively. (auth)

37790 (JINR-P-2093) OBRAZOVANIE Li^8 IZ YADER V^{51} I Au^{197} POD DEISTVIEM PROTONOV S ENERGIEI 660 Mev. (Formation of Li^8 From V^{51} and Au^{197} Nuclei Bombarded With 660-Mev Protons). Audeichikov, V.V.; Grigor'ev, E. L.; Pozhkin, O. V.; Yakovlev, Yu. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 20p. Dep.(mn).

The results are presented of an experimental study of ^8Li formation on V and Au nuclei. The comparison of these results with the evaporation model shows certain difficulties in interpreting all the experimental data within the framework of this model. (auth)

37791 (JINR-P-2114) REAKTSII ISPARENIYA NESKOL'KIKH NEITRONOV PRI OBLUCHENII URANA-238 USKORENNYMI IONAMI KISLORODA-18, FTORA-19 I NEONA-22. (Evaporation Reactions of Several Neutrons by Bombarding U-238 With Accelerated Ions of Oxygen-18, Fluorine-19, and Neon-22). Donets, E. D.; Shchegolev, V. A.; Ermakov, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1965. 19p. Dep.(mn).

The nuclear reactions of the type $^{238}U(^{18}O,xn)Fm$, $^{238}U(^{19}F,xn)Md$, $^{238}U(^{22}Ne,xn)No$ were investigated. It follows from experiments that (Γ_n/Γ_f) grows rapidly with the increasing excitation energy of the compound nucleus. The data concerning the dependence of (Γ_n/Γ_f) on Z of the compound nucleus were obtained. (auth)

37792 (KAPL-M-6452) O^{16} FAST NEUTRON CROSS SECTIONS AND LEGENDRE MOMENTS BELOW 15.0 Mev. Slaggie, E. L.; Reynolds, J. T. (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 30, 1965. Contract W-31-109-eng-52. 33p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Fast neutron cross sections and Legendre moments for ^{16}O are given at energies below 15.0 Mev. Below 2.6 Mev the elastic cross section and moments are obtained analytically from a fitting formula based on a combined resonance and potential well theory. Moments above 5.0 Mev are obtained from optical calculations. These calculations are described and detailed references are given for the data on which the library is based. (auth)

37793 (MIT-2098-152) CALCULATION OF INELASTIC SCATTERING OF NEUTRONS IN THE Mev REGION. Auerbach, E. H. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science); Moore, S. O. (Brookhaven National Lab., Upton, N. Y.). [June 9, 1965]. Contract AT (30-1)-2098. 6p. (CONF-650706-14). Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

From International Conference on the Study of Nuclear Structure with Neutrons, Antwerp.

A model for inelastic scattering of neutrons by nuclei in the range up to several Mev is presented. The Hauser-Feshbach theory is assumed to explain the inelastic and

compound elastic parts of the scattering to a high degree of approximation. The assumption that the complex potential describing the elastic part of the scattering is adequate to provide the transmission coefficients applicable to the excited states which are required for the Hauser-Feshbach calculation is made. (M.O.W.)

37794 (NASA-TN-D-2909) EMPIRICAL EQUATIONS FOR ELECTRON BACKSCATTERING COEFFICIENTS. Koral, Kenneth F.; Cohen, Allan J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). July 1965. 18p. $1.00(CFSTI)

Empirical equations were obtained for electron backscattering coefficients in the energy range 0.6 to 1.8 Mev. These equations give normal-incidence backscattering coefficients and approximate angular-incidence backscattering coefficients as functions of thickness, atomic number, and energy. Materials involved were metals with atomic numbers ranging from 13 to 79. Additional data are presented to allow extrapolation of the formulas to include incident energies between 5.0 kev and 3.0 Mev. By using the empirical equations, an upper limit was calculated for the fraction of electrons backscattered from the collector to the emitter of a beta radioisotope cell. For the particular proposed design considered, the upper limit indicated that electron backscattering from the collector would cause, with the proper material, only moderate efficiency losses in the cell. (auth)

37795 (NP-15109) PHASE-SPACE INTEGRALS FOR BETA-DECAY AND NUCLEAR MATRIX ELEMENTS. Bahcall, John N. (California Inst. of Tech., Pasadena). [1963]. Contracts Nonr-220(47) and NGR-05-002-028. 12p.

The use of phase-space integrals to determine nuclear matrix elements is discussed. The procedure for determining matrix elements is illustrated by analyzing the allowed and superallowed beta-decays of isotopes with mass numbers in the range five to ten, utilizing the recent summary of the properties of nuclei in this region compiled by Ajzenberg-Selove and Lauritsen. Some f-values for other beta-decays of interest are also given. (auth)

37796 (NP-15230) O DELENII YADER CHEREZ KVAZIMOLEKULYARNYE SOSTOYANIYA. (On The Fission of Nuclei Through Quasimolecular States). Shigin, V. A. (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 14p. (IAE-796). Dep. mn.

A mechanism of nuclear fission through quasimolecular (QM) states is proposed. The possibility of such states is substantiated. The stability of QM states with respect to the merging and scission of the nuclei involved is brought about the presence in the nucleus of structures of nucleons and the consequent additional rigidity of the nucleus to deformation. At the same time, these states are unstable toward exchange of nuclei by nucleons. The calculation of QM states leads to a new representation of the fission process, according to which fission consists of the growth of a light nucleus on the surface of the fissioning nucleus after transition of the surface nucleons from the remainder, in which the nucleons are coupled less strongly than in the light nucleus, and of the subsequent scission of the developing quasimolecule. The growth of the light nucleus begins with alpha particles. This mechanism offers the possibility of a new approach to the problems of fragment mass asymmetry and effects of fragment shells while preserving usual approach to the questions of fragment kinetic energy and neutron evaporation from fragments. An explanation of some laws of fission is given on the basis of the QM mechanism. Experiments permitting the QM mechanism of fission to be distinguished from the drop mechanism are pointed out. (tr-auth)

37797 (NP-15236) SPEKTR GAMMA-LUCHEI, VOZNIKAYASHCHIKH PRI ZAKHVATE TEPLOVYKH NEITRONOV ZOLOTOM. (Spectrum of Gamma Rays Occurring During Thermal Neutron Capture by Gold). Groshev, L. V.; Demidov, A. M.; Shadiev, N. (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1964. 10p. (IAE-772). Dep. mn.

The spectrum of gamma rays emitted upon capture of thermal neutrons by gold was measured by a magnetic spectrometer with resolution of 0.3%. The energies and intensities of 53 lines in the energy range 4.4 to 6.6 Mev were determined. The neutron binding energy in ^{198}Au was found to equal 6508 ± 4 kev. Excitation energies of the ^{198}Au levels were determined on the basis of the data obtained. A discussion of this level scheme is presented, and correlation with the scheme found in work where a diffraction spectrometer was used for measuring the gamma spectrum is given. The two schemes are found not to be in agreement. (tr-auth)

37798 (NYO-1480-18) VARIATIONAL STUDIES OF THE FEW BODY NUCLEUS. Aranoff, S.; Percus, J. K. (AEC Computing and Applied Mathematics Center, New York Univ., N. Y.). Apr. 15, 1965. Contract AT(30-1)-1480. 91p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A model triton, consisting of three bodies interacting via a two-body central gaussian potential, is studied. A type of polarized gaussian wave function is used in a minimal principle for the energy; this function gives significantly lower energy than the unpolarized wave function. The binding energy compares very well with an exact numerical solution of the problem, as well as the energy obtained by other means. Similar results were obtained for the alpha particle. A three-body potential can be written down in various ways so that the wave function is an exact solution of the hamiltonian formed by adding this potential to the original hamiltonian. One way of considering this function is in coordinate space. A simple function is found to approximate this function in regions where the wave function is not small. It has the form of a gaussian times a quadratic expression. Another way is using projection operators. This method is used for calculations of an upper bound for the mean square radius, involving an extension of the ideas of a previous calculation of an upper bound for the kinetic energy of two electrons. A variational principle for quantities other than the energy was set up. This theory was applied to the mean square radius. (auth)

37799 (NYO-1930-43) A STUDY OF SYMMETRIC FISSION OF LIGHT ELEMENTS (thesis). Baba, Horishi (Clark Univ., Worcester, Mass.). [1964]. Contract AT(30-1)-1830. 143p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

The possibility of the existence of symmetric fission in elements as light as rhodium was studied. It has been predicted that symmetric fission disappears when the fissionability parameter $\underline{x}$ becomes less than 0.395. This parameter is the coulomb energy of a nucleus divided by twice its surface energy, or alternatively, $(Z^2/A)/48.0$ where Z is the charge of the liquid drop, and A is the mass number. Since the detection of symmetric fission was expected to be extremely difficult in the boundary region, indium, whose $\underline{x}$-value is somewhat higher than 0.395, was chosen as a starting nucleus in which symmetric fission should be relatively easily detected. Lighter elements were then studied to determine the critical point where symmetric fission disappears. Silver and indium were irradiated with protons of 60, 100, and 140 Mev, and rhodium with protons of 100 and 140 Mev. Thick targets were used since extremely small fission cross sections were expected. Irradiated targets were dissolved, carriers added, and several elements were chemically separated, including Ca, Sc, Mn, Fe, Co, Ni, and Zn, and, in a few cases, Cr and Sr. The identification of radionuclides and the determination of their yields were carried out by counting β and γ activities. The absolute magnitude of the yields of the nuclides was roughly measured by monitoring the beam intensity with the ^{27}Al(p,3pn)^{24}Na and ^{65}Cu(p,pn)^{64}Cu reactions. Total chain yields were then calculated from the observed independent and cumulative yields by applying a reasonable correction for charge distribution. A peak indicative of symmetric fission was observed in the mass-yield curve for both indium and silver targets. The yields increase and the peak becomes broader as the proton energy increases. The

mass-yield curve for rhodium targets did not have any apparent peak structure. There appears to be a discrepancy between the predicted and experimentally observed $\underline{x}$-values for the fission boundary. A static model of nuclear fission is considered in which degrees of freedom with respect to the partition of the nuclear charge and internal excitation are introduced. Calculations based on the model gave the most probable charge for a given fragment mass and the charge and mass distributions. The discrepancy in limiting $\underline{x}$ was removed, and reasonable results for the other quantities were obtained by approximating the saddle-point shape of the fissile nucleus by a configuration consisting of two spheroids in contact. Thermal equilibrium was assumed at the saddle point to calculate thermodynamic quantities of the system. (auth)

37800 (ORNL-3778(p.22-3)) HARTREE-FOCK CALCULATIONS OF FINITE NUCLEI. Davies, K. T. R.; Baranger, M. (Oak Ridge National Lab., Tenn.).

A different way of setting up parameters for Green's velocity-dependent potential is discussed. It is suggested that this potential may be used as an "effective interaction" in nuclear Hartree-Fock calculations. A method for calculating oscillator brackets has been developed and should be useful in computations that involve only relative s, p, and d waves. (auth)

37801 (ORNL-3778(p.24-5)) CALCULATION OF THE PROPERTIES OF THE GROUND STATE OF ^{16}O IN THE BRUECKNER APPROXIMATION. Becker, R. L.; MacKellar, A. D. (Oak Ridge National Lab., Tenn.).

A reaction-matrix calculation for closed-shell nuclei is described. The Bethe-Goldstone equation is solved directly for nuclear pairs initially in harmonic oscillator states. The tensor force is treated accurately by solving coupled equations. Some results are presented for ^{16}O. (auth)

37802 (ORNL-3778(p.28)) PRIOR-FORM DWBA STRIPPING PROGRAM. Gibson, F. P. (Oak Ridge National Lab., Tenn.).

A computer program is outlined that calculates the d-p stripping differential cross section, using the prior form of the distorted-wave Born approximation matrix element. (auth)

37803 (ORNL-3778(p.37)) POSSIBLE ADMIXTURE OF ONE-PHONON 2^+-STATE AMPLITUDE TO THE SECOND EXCITED STATE OF ^{64}Zn. Tamura, Taro (Oak Ridge National Lab., Tenn.).

Scattering of 17.5-Mev protons by ^{64}Zn was analyzed in terms of the coupled-channel calculation. (T.F.H.)

37804 (ORNL-3778(p.38-44)) LEVEL SPACINGS AND s-WAVE NEUTRON STRENGTH FUNCTIONS OF THE ISOTOPES OF HAFNIUM. Fuketa, T.; Harvey, J. A. (Oak Ridge National Lab., Tenn.).

Neutron transmission measurements from 0.2 to ~240 ev have been made on enriched samples of the six isotopes of hafnium. About one hundred resonances were analyzed to obtain the average level spacing and s-wave strength function for each isotope. (auth)

37805 (ORNL-3778(p.44-53)) HIGH-RESOLUTION MEASUREMENTS OF THERMAL NEUTRON CAPTURE GAMMA RAYS. Slaughter, G. G.; Harvey, J. A. (Oak Ridge National Lab., Tenn.).

A lithium-drifted germanium crystal was used to make high-resolution measurements of the gamma rays following thermal neutron capture in samples of Bi, Nb, Y, and enriched samples of ^{238}U and the Sn isotopes. Gamma-ray energies (measured to ±10 kev) and relative intensities are correlated with level energies and spins measured by the (d,p) reaction. (auth)

37806 (ORNL-3778(p.53-64)) CAPTURE CROSS-SECTION MEASUREMENTS ON ^{182}W, ^{183}W, ^{184}W, AND ^{186}W AT THE RPI LINAC. Block, R. C.; Russell, J. E.; Hockenbury, R. W. (Oak Ridge National Lab., Tenn.).

Capture cross-section measurements were made upon samples of ^{182}W, ^{183}W, ^{184}W, and ^{186}W with a 1.25-m-dia liquid-scintillator detector. In the energy region up to 4000 ev, 66 resonances were detected in ^{182}W, 47 in ^{184}W, and 45 in ^{186}W; 116 resonances were observed in ^{183}W up to 3000 ev. The data have been reduced to capture cross sections as a function of energy from ~35 ev to 10 kev. (auth)

37807 (ORNL-3778(p.64-9)) GAMMA-RAY SPECTRA FROM NEUTRONS CAPTURED IN ^{56}Fe AT THE 1148-ev RESONANCE. Block R. C. (Oak Ridge National Lab., Tenn.).

The large NaI crystal at the ORNL fast chopper was used to measure the gamma-ray spectrum from neutrons captured in the 1148-ev resonance in ^{56}Fe. Five distinct gamma rays were observed at energies of 7.64, 7.48 ± 0.08, 6.36 ± 0.04, 4.9 ± 0.1, and 4.4 ± 0.1 Mev with relative strengths of approximately 10, 2, 4, 1, and 1 respectively. Comparative measurements were carried out for thermal neutron capture in iron, and it was observed that the intensity of photons per capture was the same in resonance and thermal capture for the 7.64-Mev gamma ray. (auth)

37808 (ORNL-3778(p.69-75)) STUDY OF THE EVEN-EVEN COMPOUND NUCLEI AT THE FIRST s-WAVE STRENGTH FUNCTION RESONANCE. Good, W. M.; Paya, Daniel; Wagner, Rolf (Oak Ridge National Lab., Tenn.).

The even-odd target nuclei in the region of the first s-wave resonance have been studied for manifestation of the 28-neutron shell closure. Results indicate the strength functions predicted by optical model, but non-uniformly distributed below 60 kev. (auth)

37809 (ORNL-3778(p.76-81)) A STUDY OF THE RESONANCE STRUCTURE OF THE EVEN ZIRCONIUM ISOTOPES AT BELOW 60-kev NEUTRON ENERGY. Biggerstaff, J. A.; Good, W. M.; Kim, H. J. (Oak Ridge National Lab., Tenn.).

The neutron resonance structure of the even isotopes of zirconium has been studied up to 60 kev. Below about 20 kev, the average strength is $(1.2 \pm 0.8) \times 10^{-4}$. From 20 kev to 60 kev, the strength is $(2.5 \pm 0.6) \times 10^{-4}$. (auth)

37810 (ORNL-3778(p.85-8)) DIFFERENTIAL SCATTERING OF NEUTRONS FROM ^{16}O. Johnson, C. H.; Fowler, J. L. (Oak Ridge National Lab., Tenn.).

A phase-shift analysis of differential scattering of neutrons from ^{16}O at a number of energies between 2 and 4 Mev gives the following resonant parameters for resonances in ^{17}O: (3.40, $\frac{3}{2}^+$, 0.5), (3.75, $\frac{3}{2}^-$, 0.2), (3.77, $\frac{5}{2}^-$, 0.1), and (3.82, $\frac{3}{2}^+$, 0.05), where the resonant energy in Mev is followed by the J-value, parity, and reduced widths in units of $3\hbar^2/2ma^2$. (auth)

37811 (ORNL-3778(p.94)) TOTAL NEUTRON CROSS SECTIONS OF HYDROGEN AND CARBON IN THE 20–30 Mev REGION. West II, M. L.; Jones, C. M.; Willard, H. B. (Oak Ridge National Lab., Tenn.).

The total cross sections of ^{1}H and ^{12}C for neutrons have been measured from 19.58 to 30.46 Mev. (auth)

37812 (ORNL-3778(p.95-7)) CROSS SECTIONS FOR (p,n) REACTIONS IN FIVE ISOTOPES OF TIN. Kernell, R. L.; Johnson, C. H. (Oak Ridge National Lab., Tenn.).

Cross sections for (p,n) reactions have been measured from 2.5 to 5.5 Mev. At 5 Mev, the cross sections range from 16.2 mb for ^{117}Sn to 21.5 mb for ^{124}Sn. A value of Q = −3465 ± 7 kev was determined for the reaction ^{120}Sn (p,n)^{120}Sb. (auth)

37813 (ORNL-3778(p.97-100)) ISOBARIC ANALOG STATES IN ^{90}Zr, ^{114}Sb, ^{118}Sb, AND ^{120}Sb. Johnson, C. H.; Kernell, R. L. (Oak Ridge National Lab., Tenn.).

The main purpose of this work was to measure with good resolution the (p,n) cross sections near isobaric analog resonances for targets of ^{89}Y, ^{115}Sn, ^{117}Sn, and ^{119}Sn. The energies for the 2^- and 3^- resonances in ^{89}Y(p,n) are found to be 4804 ± 6 kev and 5007 ± 6 kev, and the total widths Γ for both are about 25 kev. Resonances are observed at 4300 ± 15 kev for ^{115}Sn(p,n), 4491 ± 6 kev for ^{117}Sn(p,n), and 4642 ± 6 kev for ^{119}Sn(p,n). The positions of these resonances indicate that they are 0^+ analogs to the ground states of even tin isotopes. The natural widths for the two heavier targets are each 30 kev, and the width for the ^{115}Sn

target is about 30 kev. In addition, a threshold was found at 4751 ± 7 kev for ^{89}Y(p,n), which corresponds to a level at 1084 ± 8 kev in ^{89}Zr. The fact that this threshold is observed indicates that $^5/_2^-$ is the correct one of the two possible assignments, $^1/_2^-$ or $^3/_2^-$. (auth)

37814 (ORNL-3778(p.101-3)) ELASTIC AND INELASTIC SCATTERING OF 12- AND 13-Mev PROTONS FROM ^{106}Pd AND ^{108}Pd. Robinson, R. L.; Ford, J. L. C. Jr.; Stelson, P. H.; Satchler, G. R. (Oak Ridge National Lab., Tenn.).

The differential cross sections for elastic scattering and inelastic scattering of 12- and 13-Mev protons to the quadrupole, two-phonon, and octupole states of ^{106}Pd and ^{108}Pd have been measured. Comparisons are made with the predictions of the distorted-wave theory for direct nuclear interactions. (auth)

37815 (ORNL-3778(p.104-10)) ^{15}N(^{3}He,p)^{17}O AND ^{15}N(^{3}He,d)^{16}O REACTIONS AND INTERMEDIATE RESONANCES. Seth, K. K.; Walter, G.; Miller, P. D.; Biggerstaff, J. A.; Satchler, G. R. (Oak Ridge National Lab., Tenn.).

The ^{15}N(^{3}He,p)^{17}O and ^{15}N(^{3}He,d)^{16}O reactions have been investigated. An angular distribution was measured at 6.41 Mev. The results were interpreted in terms of states in ^{16}O and ^{17}O consisting of one or two particles, respectively, being captured into 2s-1d shells. The $p_{\frac{1}{2}}^{-1}$ core of the ^{15}N target was preserved. (auth)

37816 (ORNL-3778(p.112-15)) LOW-LYING LEVELS IN ^{75}As. Robinson, R. L.; Ford, J. L. C. Jr.; McGowan, F. K.; Stelson, P. H. (Oak Ridge National Lab., Tenn.).

Seven levels in ^{75}As below 900 kev have been Coulomb-excited with alpha particles and oxygen ions. Level properties for these are reported. (auth)

37817 (ORNL-3778(p.116-19)) GAMMA-RAY SPECTROSCOPY WITH A LITHIUM-DRIFTED GERMANIUM DETECTOR. Robinson, R. L.; Stelson, P. H.; McGowan, F. K.; Ford, J. L. C. Jr.; Milner, W. T. (Oak Ridge National Lab., Tenn.).

The energies of gamma rays from about 50 nuclides have been measured to within a few tenths of a kev. Gamma-ray doublets in the decay of ^{102}Rh and ^{106}Rh and in the Coulomb excitation of ^{77}Se are reported. (auth)

37818 (ORNL-3778(p.119-22)) DECAY OF ^{79}Kr → ^{79}Br. Robinson, R. L. (Oak Ridge National Lab., Tenn.).

Singles and coincidence gamma-ray spectra of the decay of ^{79}Kr are investigated. An energy-level diagram of ^{79}Br based on these results is proposed. (auth)

37819 (ORNL-3778(p.129-39)) FISSION FRAGMENT ENERGY CORRELATION EXPERIMENTS. Schmitt, H. W.; Neiler, J. H.; Walter, F. J. (Oak Ridge National Lab., Tenn.).

Experimental results based on absolute energy calibrations are given for ^{252}Cf spontaneous fission and ^{235}U thermal-neutron-induced fission. (auth)

37820 (ORNL-3778(p.140-6)) CORRELATED FRAGMENT ENERGY MEASUREMENTS AND MASS-vs-ANGLE CORRELATIONS IN ^{226}Ra + p FISSION. Schmitt, H. W.; Dabbs, J. W. T.; Miller, P. D. (Oak Ridge National Lab., Tenn.).

Mass distributions and mass-energy correlations have been studied for E_p = 11.0, 12.0, and 13.5 Mev. For E_p = 13.5 Mev, a small variation in the mass distribution as a function of angle was found. (auth)

37821 (ORNL-3778(p.152-3)) SEARCH FOR HYPERFRAGMENTS IN THE Σ^- + He REACTION. Cohn, H. O.; Bugg, W. M. (Oak Ridge National Lab., Tenn.).

400 Σ^--hyperon interactions are examined in helium for possible hyperfragment formation. The Σ^- hyperons were produced by slow K^- mesons in a helium bubble chamber. Energetically, the only permissible hyperfragments are hydrogen and neutron hyperfragments. Five hydrogen hyperfragments were identified. A search for neutron hyperfragments yielded a negative result. (auth)

37822 (ORNL-3800) ELECTRONUCLEAR DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1964. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 115p. Dep.; $4.00(cy), 2(mn) CFSTI.

Four sections are included; separate abstracts have been prepared for all. (T.F.H.)

For abstracts of individual sections see: 37248, 37249, 37823, and 37824.

37823 (ORNL-3800(p.1-49)) EXPERIMENTAL NUCLEAR PHYSICS. (Oak Ridge National Lab., Tenn.).

Experimental results on a variety of nuclear reactions induced by p, d, α, ^{14}N, ^{16}O, and ^{19}F are presented and analyzed using nuclear models and reaction models. Nuclear decays are also studied. (T.F.H.)

37824 (ORNL-3800(p.50-7)) THEORETICAL PHYSICS. (Oak Ridge National Lab., Tenn.).

Theoretical nuclear physics studies reviewed include: shell-model calculations for ^{62}Ni states; shell-model effective-interaction calculations of states of ^{92}Mo, ^{93}Mo, ^{94}Mo, ^{92}Nb, ^{94}Nb, and ^{92}Zr; and distorted-wave theory of (^{3}He,d) and (t,d) reactions with nuclei, with reference to ^{48}Ca(^{3}He,d) as an example. (T.F.H.)

37825 (ORNL-P-1226) NEUTRON CAPTURE CROSS SECTIONS FROM 5- TO 100 kev. Macklin, R. L.; Gibbons, J. H. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 7p. (CONF-650706-1) Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

From International Conference on the Study of Nuclear Structure with Neutrons, Antwerp.

Regularities in neutron capture data and inadequacies in available data and techniques are discussed. The contribution of resonance capture in lighter nuclides and in those close to closed shells to total capture in a broad neutron spectrum is analyzed. Data on capture in elements and isotopes with unresolved resonances are considered. Improvements in measurement techniques are surveyed. (M.J.T.)

37826 (ORNL-P-1248) SOME CONVERSION COEFFICIENTS WHICH SHOULD BE MEASURED. Artna, Agda (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 5p. (CONF-650525-2). Dep.(mn), $1.00 (cy), 1(mn) CFSTI.

From International Conference on the Internal Conversion Process, Nashville.

A number of cases are pointed out where a measurement of the conversion coefficient or of the conversion coefficient ratios would be of considerable interest. These cases fall into three groups. 1. Values of conversion coefficients in apparent disagreement with theory have been reported in some rare-earth nuclei, for example in ^{175}Lu and ^{177}Lu. Further study of cases where disagreement between experiment and theory is indicated or expected would be of interest. 2. Different experiments have led to different conclusions about the transition multipolarity. For example, δ obtained from angular correlation experiment does not agree with δ^2 obtained from conversion electron studies (^{172}Yb, ^{181}Ta). 3. Conversion coefficients are not known to a desired precision. No values of conversion coefficients or ratios have been reported. Knowledge of these would be helpful in assigning spins and parities to nuclear levels, for example ^{163}Dy, ^{169}Er. (auth)

37827 (ORNL-P-1256) A SURVEY OF E1 TRANSITIONS IN THE RARE-EARTH REGION. Ewbank, W. B. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 13p. (CONF-650525-3) Dep.(mn); $1.00(cy), 1(mn) CFSTI

From International Conference on the Internal Conversion Process, Nashville, Tenn.

A review of the lifetimes and conversion properties of all predominantly E1 transitions in rare-earth nuclei confirmed the correlation between the γ-ray hindrance and the observed anomalies in internal-conversion coefficients. It is shown that the anomalies occur only in those transitions for which internal conversion is allowed by the interaction of orbital electrons with the nucleon spin-current inside the nucleus. The coefficients for conversion of a transition in the K shell and in the L_1, L_2 subshells are shown to be in-

creased by about the same factor over their theoretical values. (auth)

37828 (ORNL-P-1375) ON THE ABSOLUTE VALUE AND ENERGY DEPENDENCE OF THE ^{3}He(n,p)T REACTION. Macklin, R. L.; Gibbons, J. H. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 10p. (CONF-650706-16). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Conference on the Study of Nuclear Structure with Neutrons, Antwerp.

Proton beam currents of from 0.05 to 1.0 μa were used. The tritium targets were composed of tritiated titanium thin films (14-25 μ gm/cm^2) on a variety of metal backings. The ^{49}Ti(p,n) threshold limited the proton energies used to about 1.4 Mev. Target thickness varied from 2 to 4 kev for 1 Mev protons. The final yield results were converted to ^{3}He(n,p)T by detailed balance and normalized to a value of 1980 mb at 100 kev. (M.O.W.)

37829 (RCN-INT-63-043) TABLE OF ALPHA EMITTING NUCLIDES, LISTED ACCORDING TO INCREASING ENERGY OF THE ALPHA RADIATION. Post, J. C. (Reactor Centrum Nederland, Petten). July 1963. 21p. Dep. mn.

The table is divided into 5 columns: alpha energy, nuclide, relative abundance of the alpha energy, half life, and total alpha branching percentage. (M.O.W.)

37830 (TID-21937) A STUDY OF HYPERFRAGMENTS PRODUCED BY 2.3-Bev/c K$^-$ INTERACTIONS IN EMULSION (thesis). Technical Report No. 444. Prem, Ravinder Jit (Maryland Univ., College Park. Dept. of Physics and Astronomy). Apr. 1965. Contract AT(40-1)-2304. 115p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Studies were made of hyperfragments produced by 2.3-2.5 Bev/c K$^-$ interactions in nuclear emulsion. The observed features of production are discussed in view of proposed models. The large abundance of short-range hyperfragments (R ≤ 5 μ) is satisfactorily explained in terms of the spallation model. The longer range hyperfragments are a result of nuclear evaporation processes. Some evidence for the existence of direct-production or prompt-emission mechanism is found from the observation of forward-moving energetic light hyperfragments. The lifetimes of hydrogen and helium hypernuclei ($^3_\Lambda$H, $^4_\Lambda$H, and $^5_\Lambda$He) were measured. Also one in-flight and nine at-rest decays of $^4_\Lambda$He → ^{3}He + p + π$^-$ were observed in an estimated time of 1.50×10^{-10} sec. The results are in agreement with the previous investigations, but with large statistical errors. These lifetimes are combined with similar experimental results and are then compared with the theoretical estimates. Also presented are the Λ-particle binding energies from 43 uniquely identified mesic decays. The results are in good agreement with previously reported values. Based on the analysis of two short-range mesic hyperfragments, the Λ-particle binding-energy limit is found to be 22.1 Mev. This value is consistent with previously reported values and also with theoretical estimates. (auth)

37831 (TID-21940) [PHOTONEUTRON PRODUCTION CROSS SECTIONS FOR LIGHT NUCLEI]. Final Report, January 15, 1965. Whitehead, W. D. (Virginia Univ., Charlottesville). Contract AT(40-1)-2841. 47p. Dep. (mn).

Research on the determination of photoneutron production cross sections for light nuclei is summarized, and a list of papers on these studies is given. Three articles are included; separate abstracts were prepared for each. (M.J.T.)

For abstracts of individual papers see: 37832, 37833, and 37834.

37832 (TID-21940(Paper I)) ELECTRIC DIPOLE PHOTON ABSORPTION IN S^{32}. Spicer, B. M. (Virginia Univ., Charlottesville). 8p.

The particle-hole model is applied to the calculation of E1 photon absorption by ^{32}S. A plausible unperturbed spectrum was obtained from investigation of the results of the ^{32}S(d,p)^{33}S and ^{32}S(p,2p)^{31}P reactions. The results of the calculation are compared with experiment, and suggestions are made with reference to the shortcomings of the calculation. (auth)

37833 (TID-21940(Paper II)) THE TOTAL PHOTONEUTRON CROSS SECTIONS OF CARBON AND MAGNESIUM. Min, K.; Whitehead, W. D. (Virginia Univ., Charlottesville). 19p.

The total photoneutron cross sections of natural carbon and magnesium were measured from thresholds to 30 Mev. The neutron yield curves, determined in 0.5 Mev intervals using a bremsstrahlung beam, were analyzed by the Penfold-Leiss method to obtain two independent sets of cross sections of 1 Mev interval. The carbon cross section exhibits major structure at 18.8, 22.0, 23.0, and 25.5 Mev, with the integrated cross section up to 28 Mev, 39.2 Mev-mb. The magnesium cross section indicates levels at 17.0, 19.5, 21.5, 23.5, and 25.5 Mev with the integrated cross section up to 28 Mev, 90.7 Mev-mb. The magnesium cross section also shows a smaller structure at 14.7 Mev due to ^{25}Mg and ^{26}Mg. The experimental results are compared with the available particle-hole model calculations of E1 levels. (auth)

37834 (TID-21940(Paper III)) PHOTOEXCITATION OF M1 AND E2 LEVELS IN O^{16}. Spicer, B. M.; Eisenberg, J. M. (Virginia Univ., Charlottesville). 16p.

The possibilities of establishing a plausible unperturbed spectrum for ^{16}O through the consideration of relatively highly excited states in ^{15}O and ^{17}O are explored, and an attempt is made to explain the appearance of prominent even-parity resonances in the giant resonance on the basis of a 1p-1h calculation. The level scheme of particle and hole states in ^{16}O is established. The diagonalization of the secular matrices based on this unperturbed spectrum yields the energy eigenvalues, eigenvectors, and relative transition strengths for the E2, T = 0, 1 levels and the energy eigenvalues and eigenvectors for the M1, T = 0, 1 levels. (M.J.T.)

37835 (TID-22024) NUCLEAR CHEMISTRY RESEARCH OF HIGH ENERGY NUCLEAR REACTIONS, 1964-1965. A. RESEARCH PROGRESS REPORT. Caretto, Albert A., Jr. (Carnegie Inst. of Tech., Pittsburgh, Pa.). May 1, 1965. Contract AT(30-1)-2897. 42p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Summaries are presented of work on the following subjects: production of ^{24}Na and ^{22}Na with protons, target thickness effects on (p,xn) reactions, ^{24}Na and ^{22}Na production from Mg, (N,2N) reactions of Cd isotopes, target preparation, ^{89}Nb and ^{89}Nb decay, and Monte Carlo evaporation program. (D.L.C.)

37836 (UCRL-11338(Rev.1)) STUDIES IN THE LIQUID-DROP THEORY OF NUCLEAR FISSION. Nix, James Rayford; Swiatecki, Wladyslaw J. (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 1, 1964. Contract W-7405-eng-48. 213p. Dep.(mn); $6.00(cy), 4(mn) CFSTI

In connection with nuclear fission the division of an idealized charged drop is studied, using a simplified version of the liquid-drop model. The degrees of freedom essential to a discussion of the division of a charged drop and the separation of the fragments to infinity are taken into account: a fragment-separation coordinate, a mass-asymmetry coordinate, a deformation coordinate for each fragment, and rotational coordinates for each fragment. To specify fragment deformation, the fragments are represented by spheroids; a nucleus prior to division is represented by two overlapping spheroids. The hamiltonian for the idealized system consists of a sum of surface, Coulomb, and kinetic energies. A study of the saddle-point energies and shapes calculated in this two-spheroid approximation indicates that the approximation is most useful for discussing the fission of elements lighter than about radium. On the basis of this model, probability distributions are calculated for certain observable characteristics of fission fragments at infinity-their total translational kinetic energy, mass, individual excitation energies, and individual

angular momenta. This is done by applying standard static, dynamical, and statistical methods to the hamiltonian for the system. The treatment, for the most part, is classical; quantum mechanics is considered only in the statistical-mechanics discussion of the behavior of the system near the saddle point. The predictions of the model are compared with existing experimental data for distributions in fragment mass and total translational kinetic energy, for nuclei lighter than radium. The comparisons are made without the use of any adjustable parameters. The theory is capable of accounting for the magnitudes of the most probable values and widths of the experimental distributions, as well as some, but not all, finer details of the distributions. The dependence of the experimental distributions upon nuclear temperature, and the dependence of the experimental most probable kinetic energies upon fissionability parameter are also approximately reproduced by the calculations. (auth)

37837 (UCRL-16027) ANGULAR CORRELATIONS INVOLVING CONVERSION ELECTRONS. Yamazaki, T. (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 1965. Contract W-7405-eng-48. 26p. (CONF-650525-4). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From International Conference on the Internal Conversion Process, Nashville, Tenn.

A brief summary is made of the advantages of angular correlation involving conversion electrons and of the current state of experimental apparatus. It is emphasized that L conversion electrons in addition to K will provide important information of nuclear structure and the conversion process. Preliminary measurements on the 333 γ–356 K, L, M, and 333 K, L, M–356 γ angular correlations in ^{196}Pt are reported. A discussion is made of a possible rearrangement effect on the conversion coefficients of a nuclear transition which follows a converted transition in cascade. (auth)

37838 (USNRDL-TR-846) STRUCTURE IN THE Al^{27} (n,α) CROSS SECTION. Ferguson, J. M. (Naval Radiological Defense Lab., San Francisco, Calif.). May 6, 1965. 12p.

The excitation function for the ^{27}Al(n,α) cross section was measured from 12.8 to 14.3 Mev. The energy resolution of the data is better than 80 kev, and the statistical errors are less than 1 percent. The data show a peak at 13.55 Mev in the cross section with a width of about 300 kev and an amplitude of about 4 percent of the average cross section in this region. (auth)

37839 (ANL-Trans-195) COUPLING EFFECTS AT THE FISSION OF AN EVEN-EVEN COMPOUND NUCLEUS NEAR THE THRESHOLD. Strutinskii, V. M.; Pavlinchuk, V. A. (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow and Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Translated by Elmar K. Wilip (Argonne National Lab., Ill.). 1965. 7p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn; JCL, $1.10 fs $0.80 mf.

The observed energy gap in the internal excitation spectrum of a fissioning even-even compound nucleus is considered. The nonuniform increase of the density of the internal levels of the compound nucleus leads to an irregular increase of the internal excitation energy and a consequent increase of the mean number of neutrons, n, emitted in the fission process. Formulas are presented for the total density of the internal excitation levels and for the mean energy of the internal excitation, $\langle U(E)\rangle$. The observed variation of dn/dE is compared with the expected change of the energy dependence of $\langle U(E)\rangle$ for ^{235}U; the dependence of n on the incident neutron energy is shown. The assignment of the value for the energy gap is discussed. (M.J.T.)

37840 (ANL-Trans-196) THE FISSION OF DEFORMED NUCLEI. Strutinskii, V. M. Translated by Elmar K. Wilip. (Argonne National Lab., Ill.), from IAE Preprint No. 814 Presented at the International Conference on Nuclear Fission Physics, Salzburg, Austria, March 1965. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI $1.60(fs), $0.80(mf) JCL.

The so-called quadrupole interaction of nucleons in unfilled shells leads to a certain energy decrease of the nucleus at the stationary deformed initial state whereby this phenomenon disappears at a slightly higher deformation. A phenomenological model of the fission thresholds of very heavy nuclei is formulated on this basis. (auth)

37841 NUCLEAR STRIPPING REACTIONS. Ivash, Eugene V. (Univ. of Texas, Austin). Am. J. Phys., 33: 565-9(July 1965).

The theory of nuclear stripping reactions is presented in a simple fashion. It is suggested that inclusion of the subject of stripping reactions in the graduate quantum mechanics curriculum may be of great value to the student. (auth)

37842 ENERGY LEVEL SPECTRA FOR ^{118}Sn AND ^{122}Sn. Kumar, N.; Kumar, V.; Bhanot, V. B. (Panjab Univ., Chandigarh, India). Australian J. Phys., 18: 265-9(June 1965).

Shell-model calculations were made for the energy level spectra of ^{118}Sn and ^{122}Sn. Best fit with experimental data for ^{118}Sn is found for singlet s- and d-state forces of the same strength and range. Values for several unobserved levels of ^{122}Sn were predicted. (auth)

37843 CHARGED LOW-ENERGY PARTICLES IN THE PHOTOFISSION OF THE Be^9 NUCLEUS. Komar, A. P.; Makhnovskii, E. D. (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR, 160: 1300-3(Feb. 21, 1965). (In Russian)

A beryllium target 4.7 mg/cm^2 thick was irradiated in a vacuum chamber with bremsstrahlung radiation (E_{max} = 35 Mev). The particle range R and orientation of the traces in the emulsion were measured on photoplates in a uniform magnetic field (H = 13,500 oersteds) approximately perpendicular to the direction of particle emission. The particle was identified from the radius of curvature in the magnetic field. The gamma flux was determined by a quantometer. A plot of the R versus the radius of curvature shows the presence of protons, deuterons, and alpha particles. The proton distribution shows a peak at E_p = 4 Mev. The excitation function of the ^{9}Be(γ,p)^{8}Li reaction shows a maximum at E_γ = 22 Mev with E_γ varying from 18 to 26 Mev. The value of $\int_{18}^{26} \sigma_{\gamma p}(E_\gamma)\, dE_\gamma = 12 \pm 1.8$ mb-Mev. The experimental cross section for the (γ,p) reaction with ^{9}Be was found to be 1.05 mb in good agreement with the theoretical value of 1.06 mb. The ratio of deuteron yield $y_d/y_p = 0.20 \pm 0.10$. About 90 deuterons were identified in the experiment. The cross section of the photoreaction resulting in deuteron emission is 6 to 7% of the total cross section for the absorption of gamma quanta having energies from 16.7 to 35 Mev. The alpha energy spectrum shows two wide alpha peaks at E_α = 6 and 10 Mev from the reaction ^{9}Be(γ,n)^{8*}Be $\rightarrow 2\alpha$. The cross section for the absorption of gamma quanta by the ^{9}Be nucleus was found to be 6 ± 1 mbs. (TTT).

37844 ELASTIC SCATTERING OF 10 Gev PROTONS BY THE HYDROGEN OF THIN $(CH_2)_n$ TARGET. Markov, P. K.; Chernev, Kh. M. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk, 13: 233-43(1965). (In Bulgarian)

A $(CH_2)_n$ target with a thickness of about 2.5 μ was exposed to the 10-Bev proton beam of the Dubna synchrophasotron. The layout of the experiment is shown. Three photoemulsion stacks recorded the secondary particles emitted in the region from 80°30′ to 88° in the laboratory system. The distributions of the secondary particles according to their ranges at different angles are given. The observed peaks correspond to the recoil protons of the elastic scattering from the hydrogen of the target. A total of 7434 recoil protons was registered, and the differential cross sections at 10 angles were calculated in relative units. The data were fitted to previous results. The slope of the diffraction cone and the radius of the proton were found to be $a = (9.9 \pm 0.6)(Bev/c)^{-2}$ and $r = (1.24 \pm 0.04)$ fermi, respectively. (auth)

37845 PRECISE EXPERIMENTAL STUDY OF β SPECTRA. Quivy, R.; Franeau, J. (Institut Interuniversitaire

des Sciences Nucleaires, Mons, Belg.). J. Phys. (Paris), 26: 241-5(May 1965). (In French)

The great influence of the thickness of the β-source support on experimentally determined spectrum deformation is shown, all other precautions having been taken for the measurements. It is not possible to prepare a support thin enough for the low energy part of the β-spectrum not to be distorted. It was verified that this deformation is caused by backscattering effects. A correction method which is simple and quick is proposed. In the cases considered, the corrected spectra are in good agreement with theory. (auth)

37846 IRON-54 (n,p) CROSS-SECTION MEASUREMENT. Carroll, Edward E. Jr.; Smith, George G. (Westinghouse Electric Corp., West Mifflin, Penna). Nucl. Sci. Eng., 22: 411-15(1965). (WAPD-T-1726)

The $^{54}Fe(n,p)^{54}Mn$ cross section was measured at eleven points between 3.55 Mev and 17.4 Mev using an activation technique. The excitation function appears to reach a peak at about 5.7 Mev. A fission-neutron cross section based on these and earlier differential data yields a value of 67 mb, in good agreement with some recent integral measurements. (auth)

37847 HALF-LIFE DETERMINATIONS BY DIRECT DECAY. Flynn, K. F.; Glendenin, L. E.; Steinberg, E. P. (Argonne National Lab., Ill.). Nucl. Sci. Eng., 22: 416-19(1965).

The half lives of ^{35}S, ^{89}Sr, ^{93m}Nb, ^{95}Nb, ^{95}Zr, ^{103}Ru, ^{106}Ru, ^{113}Cd, ^{121}Sn, ^{125}Sb, ^{134}Cs, ^{144}Ce, ^{147}Pm, ^{151}Sm, ^{170}Tm, ^{171}Tm, ^{204}Tl, and ^{242}Cm were measured by direct decay. The method of least squares was used to obtain the best straight-line fit to the data. The results are compared with values in the literature, and average values of the existing determinations are given. (D.C.W.)

37848 STUDY OF THE $^{27}Al(d,\alpha)^{25}Mg$ AND $^{27}Al(d,p)^{28}Al$ NUCLEAR REACTIONS AT 2 Mev DEUTERON ENERGY. Gadioli, E. (Universita, Milan); Iori, I.; Mangialaio, M.; Pappalardo, G. Nuovo Cimento (10), 38: 1105-32(Aug. 1, 1965).

Differential excitation functions and angular distributions from 30 to 150° were measured for the $^{27}Al(d,\alpha)^{25}Mg$ and $^{27}Al(d,p)^{28}Al$ reactions leading to the ground state and to the first excited states of the residual nuclei ^{25}Mg and ^{28}Al, in the deuteron energy range (1.4 ≪ 2.3)Mev. The overall energy resolution was 10 kev for the differential excitation functions and 20 kev for the angular distributions. Fluctuations occurring in the differential excitation functions as well as in the integrated cross sections were analyzed on the basis of the statistical theory. In particular, with the use of correlation functions, values of $\Gamma = (40 \pm 10)$ kev and $\theta_0 \simeq 30°$ were deduced for the coherence energy and the coherence angle, respectively. The theoretical values of Γ and the average values of the integrated cross sections were evaluated using a consistent set of parameters. The analysis showed that the predictions of the statistical model agree with the experimental results for the $^{27}Al(d,\alpha)^{25}Mg$ reactions. Both statistical and nonstatistical effects were found to contribute to the $^{27}Al(d,p)^{28}Al$ reaction for the proton transitions leading to the low-lying levels of the residual nucleus. (auth)

37849 ($^3He,\alpha$) REACTIONS ON ^{25}Mg AND ^{26}Mg AT 5.50 Mev. Filosofo, I.; Pellegrini, F. (Universita, Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cimento (10), 38: 1133-41(Aug. 1, 1965).

Angular distributions of α particles from the $^{25}Mg(^3He,\alpha)^{26}Mg$ and $^{26}Mg(^3He,\alpha)^{25}Mg$ reactions, leading to the ground and the low excited states of ^{24}Mg and ^{25}Mg, were measured at a bombarding energy of 5.50 Mev. Relative total cross sections were obtained from the experimental results for transitions to the ground, 1.37, 4.12, 4.23, 5.22, and 6 Mev states of ^{24}Mg and for transitions to the ground, 0.58, 0.98, 1.61, and 1.96 Mev states of ^{25}Mg. The ratios of the total cross sections were compared with the predictions of the theory of Hauser and Feshbach, and a satisfactory agreement was found. In addition, the transition to the ground state of ^{25}Mg in the $^{26}Mg(^3He,\alpha)^{25}Mg$ reaction seems predominantly due to a direct interaction mechanism. (auth)

37850 AN IMPROVED S-STATE WAVE FUNCTION FOR ^6He. Rahman, H. U. (Univ. of Southamptom, Eng.). Nuovo Cimento (10), 38: 1279-84(Aug. 1, 1965).

The method developed previously to modify the lowest wave function of ^6Li is applied in the case of ^6He. The lowest harmonic-oscillator shell-model wave function of ^6He, Ψ_0, is modified by applying the Gauss radial function, $Q = \Sigma_{i<j}^4 J_{ij}$ (where $J_{ij} = \exp[-r_{ij}^2/r_c^2]$ and r_c is the assumed range of nuclear forces to it. It is shown that $\langle Q\Psi_0|H|Q\Psi_0\rangle / \langle Q\Psi_0|Q\Psi_0\rangle$ gives a better approximation to the lowest eigenvalue than $\langle\Psi_0|H|\Psi_0\rangle/\langle\Psi_0|\Psi_0\rangle$. Considerable improvement is found by this method. (auth)

37851 NUCLEAR FORM FACTORS IN MUON CAPTURE BY HELIUM-3. Zaimidoroga, O. A.; Struminskii, B. V.; Sulyaev, R. M.; Falomkin, I. V.; Tsupko-Sitnikov, V. M.; Scherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Nuovo Cimento (10), 38: 1285-90 (Aug. 1, 1965).

The $\mu^- + {}^3He \rightarrow {}^3H + \nu$ reaction rate was calculated on the basis of data on form factors obtained in experiments on pion capture by ^3He and the scattering of electrons on ^3He and ^3H. Its value turned out to be $\Lambda_{^3He}^{theor} = (1515 \pm 55)$ s^{-1} and $g_A^\beta/g_V^\beta = -1.16$ and $g_P^\mu/g_A^\mu = 7$. From the comparison of $\Lambda_{^3He}^{theor}$ to experimental results the pseudoscalar constant $g_P^\mu = (8 \pm 3)g_A^\mu$ was evaluated. (auth)

37852 NUCLEUS-NUCLEUS POTENTIAL INDUCED BY BINDING NEUTRON. Bovelli, M. L. (Universita, Rome); Zambotti, G. Nuovo Cimento (10), 38: 1427-30 (Aug. 1, 1965).

Preliminary results are reported on the binding energy of a nuclear molecule composed of two clusters held together by nucleons. It is assumed that the exchanged nucleons are neutrons whose number is small enough that their interactions can be ignored and that both clusters are in the ground state of the shell model. A molecule formed by two clusters of mass numbers 94 and 138 and atomic numbers 42 and 50 and one binding neutron is studied; this system corresponds to ^{233}U and its most probable fission products. Two solutions for the binding energy are found, starting from the Schroedinger equation and using a variational method; either the neutron is bound almost exclusively to the heavy cluster and the binding is small or the neutron is more closely bound to the light cluster but gives a contribution to the heavy-cluster wave function. (M.J.T.)

37853 SCREENING CORRECTIONS IN PROBLEMS INVOLVING BOUND ELECTRONS. O'Connell, R. F. (Louisiana State Univ., Baton Rouge); Carroll, C. O. (Nuovo Cimento (10), 38: 1431-2(Aug. 1, 1965).

It is shown how the effect of screening of the Coulomb field of the nucleus by a bound atomic electron may be taken into account very simply. It is assumed that the bound and continuum-state electrons see effective atomic numbers Z_b and Z_c, respectively. The calculation of Z_b is discussed, and formulas giving the binding energy in terms of Z_b are developed. Values of Z_b and of $\sigma_b \equiv Z - Z_b$ are given for the L_1 subshell for elements with $8 \leq Z \leq 23$. (M.J.T.)

37854 EVIDENCE FOR CORE EXCITATION IN ^{27}Al. Bonazzola, G. C. (Universita, Turin and Istituto Nazionale di Fisica Nucleare, Turin); Chiavassa, E.; Bressani, T. Nuovo Cimento (10), 38: 1444-7(Aug. 1, 1965).

Experimental evidence is reported to support the core excitation model for inelastic nucleon scattering on ^{27}Al and ^{28}Si. This model predicts that angular distributions for nucleons scattered by the 0.84-, 1.01-, 2.21-, 2.73-, and 3.00-Mev states in ^{27}Al and by the 1.78-Mev 2^+ state in ^{28}Si should be similar and that cross sections for the single levels in ^{27}Al should be given by $\sigma(^{27}Al,J) = \frac{1}{10}(2J + 1)\,\sigma(^{28}Si,2^+)$. The predictions were verified using published data and results from measurements of 14.2-Mev neutron inelastic scattering. (M.J.T.)

37855 DECAY OF Ar^{41}. Pratt, William W. (Pennsylvania State Univ., University Park). Phys. Rev., 139: B509-11(Aug. 9, 1965).

A weak gamma ray was found in the decay of ^{41}Ar to ^{41}K. The energy of the gamma ray is 1.664 ± 0.007 Mev; and its

intensity, relative to that of the strong 1.293-Mev gamma ray, is $(5 \pm 2) \times 10^{-4}$. It is concluded from the results of coincidence measurements that this gamma ray is the result of a beta branch from ^{41}Ar leading to an excited state in ^{41}K at 1.664 Mev. The associated log ft value is found to be 7.7 ± 0.3. The spin and parity of the 1.664-Mev state in ^{41}K are most probably $\frac{5}{2}^+$ or $\frac{7}{2}^+$. (auth)

37856 STUDIES OF ELECTROMAGNETIC TRANSITIONS IN B^{11} AND C^{11}. Olness, J. W.; Warburton, E. K.; Alburger, D. E.; Becker, J. A. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 139: B512-31(Aug. 9, 1965). (BNL-8932)

Electromagnetic transitions in ^{11}B and ^{11}C were investigated through the reactions induced by ^{3}He bombardment of ^{9}Be targets and by deuteron bombardment of ^{10}B targets employing bombarding energies ranging from 2.0 to 3.5 Mev. Branching ratios for the decay of the bound levels of ^{11}B populated by the ^{9}Be(^{3}He,p)^{11*}B and ^{10}B(d,p)^{11*}B reactions were determined through measurements of proton-gamma coincidence spectra. The ratios of radiative width to total width for the unbound 9.19- and 8.92-Mev levels of ^{11}B were obtained as $\Gamma_\gamma/\Gamma(9.19) = 0.1$ and $\Gamma_\gamma/\Gamma(8.92) = 1.08 \pm 0.12$. Additional measurements of the direct gamma spectra employing a three-crystal NaI(Tl) pair spectrometer, and of the internal pair transitions using an intermediate-image magnetic spectrometer, complement the above results and provide information on the decay of those bound levels of ^{11}C populated by the ^{9}Be(^{3}He,n)^{11*}C and ^{10}B(d,n)^{11*}C reactions. The angular distributions of gamma rays from the four listed reactions were measured with the three-crystal pair spectrometer, and indicate significant anisotropies for those gamma rays arising from decay of the 8.92- and 7.99-Mev levels of ^{11}B and the 7.50-Mev level of ^{11}C formed in the ^{9}Be + ^{3}He bombardment. From the Doppler shifts apparent in the angular-distribution data an upper limit of $\tau < 5 \times 10^{-12}$ sec was extracted for the mean lifetime of all bound levels of ^{11}B and ^{11}C except the 6.81-Mev level of ^{11}B, which could not be studied in this manner. The intermediate-image spectrometer was used to determine the multipolarity of those internal pair transitions in ^{11}B and ^{11}C having transition energies greater than 4 Mev. These results show that the 7.99- and 7.30-Mev levels of ^{11}B and the 7.50-, 6.90-, and 6.35-Mev levels of ^{11}C decay by E1 ground-state transitions and hence have even parity, while the 8.92- and 6.76-Mev levels of ^{11}B and 6.49-Mev level of ^{11}C decay by M1 and/or E2 ground-state transitions, and hence have odd parity. Combining these results with previously available information leads to spin-parity assignments of $\frac{5}{2}^-$ and $\frac{3}{2}^+$ for the 8.92- and 7.99-Mev levels of ^{11}B, respectively, and strongly suggests the assignment $\frac{3}{2}^+$ for the 7.50-Mev level of ^{11}C. The odd-parity assignment to the 2.14-Mev level of ^{11}B is confirmed while the parity of the ^{11}C 2.00-Mev level is fixed as odd. For the remaining levels, the measurements serve to further restrict the range of possible spin-parity assignments. In addition to parities of the ^{11}B ground state and ^{11}B 6.81-Mev level are determined to be even since the beta decay of ^{11}Be to the ^{11}B $\frac{3}{2}^+$ 7.99-Mev level and the 6.81-Mev level are known to be allowed. The level schemes of ^{11}B and ^{11}C as deduced from the present results are discussed in terms of the predictions of the intermediate-coupling shell model and the weak-coupling scheme. (auth)

37857 g FACTOR OF THE 90-kev LEVEL IN ^{99}Ru AND THE PARAMAGNETIC CORRECTION IN TRANSITION ATOMS. Matthias, E.; Rosenblum, S. S.; Shirley, D. A. (Univ. of California, Berkeley). Phys. Rev., 139: B532-9 (Aug. 9, 1965). (UCRL-11900).

Using the decay of 16.1-day ^{99}Rh, the half life of the 90-kev state in ^{99}Ru was measured by observing delayed coincidences for the (354-90)- and the (529-90)-kev cascades. The result, $t_{\frac{1}{2}} = (20.7 \pm 0.3)$ nsec, is very suitable for a measurement of the Larmor precession in this level by means of the time-differential angular-correlation technique. To overcome the difficult problem of correcting for paramagnetic shielding, the g factor was determined with the Ru atoms in three magnetically different environments: with a liquid source, with Ru embedded in a copper lattice, and with Ru dissolved in Ni. In the last case the product gH_{eff} was measured as a function of an external polarizing field, yielding both the g factor and the magnetic hyperfine field of Ru in Ni. The method of using cubic metal lattices is demonstrated to be a reliable way of measuring g factors of excited nuclear states, as there are no interfering perturbation effects due to time-dependent and/or static quadrupole interactions. The final result for the g factor is $g = -0.189 \pm 0.004$, which gives, with a spin of $\frac{3}{2}$ for the 90-kev level, a magnetic moment of $\mu = -0.284 \pm 0.006$ nm. Paramagnetic shielding in liquid sources of transition elements is discussed, and g factors previously determined for such sources are shown to be in doubt by 5 to 10%. (auth)

37858 β-γ (CIRCULARLY POLARIZED) CORRELATION MEASUREMENTS IN ^{20}F AND ^{28}Al. Mann, L. G.; Bloom, S. D. (Univ. of California, Livermore). Phys. Rev., 139: B540-4(Aug. 9, 1965). (UCRL-12360)

A measurement of the asymmetry parameter A characterizing the β-γ(CP) correlation (CP ≡ circularly polarized) for the decays of ^{20}F and ^{28}Al is reported. The spin sequence of ^{20}F was already known to be $2^+(\beta^-)2^+(\gamma)0^+$ from the work of Freiburg and Soergel. The purpose of the present experiment was to reduce the error on A in order to get a more accurate value for the isospin impurity coefficient $\alpha_0(1)$ characterizing the 1.63-Mev state (2^+,T ≈ 0) in ^{20}Ne. The result is $A = 0.174 \pm 0.014$. This agrees with Freiburg and Soergel, but represents an improvement in accuracy of a factor of 5. $\alpha_0(1)$ is found to be $(1.5 \pm 2.9) \times 10^{-3}$, using the present value for A. By methods described elsewhere, the effective Coulomb matrix element $|\langle H_c \rangle|$ is found to be 14 ± 28 kev. A comparison of this value with the values for four other states in ^{20}Ne (E_x = 7.2, 13.7, 14.1, and 14.2 Mev), computed by Wilkinson using the E1 prohibition rule in self-conjugate nuclei, indicates that $|\langle H_c \rangle|$ tends to be ≲ 30 kev regardless of excitation (so long as the state is particle-stable). This result also lends support to the surmise expressed earlier that for mixing of states of the type being observed here this upper limit is independent of atomic weight; the bulk of other similar measurements have been made in the atomic weight range of 40 to 150 (with the single exception of ^{24}Na). The result for ^{28}Al is $A = -0.315 \pm 0.024$. This establishes the 3^+ assignment for the ground state of ^{28}Al and corresponds to a pure Gamow-Teller β decay ($3^+ \rightarrow 2^+$). It also rules out the possibility of a Bouchiat-type comparison of the asymmetry parameters for ^{28}Al and ^{28}P (as has been done for the cases of ^{24}Na and ^{24}Al) in order to check the conserved-vector-current hypothesis. In addition, the ^{28}Al measurement was of important practical value in verifying the polarimeter calibration, since the single gamma ray of 1.77 Mev in the ^{28}Al decay is so close in energy to the ^{20}F gamma energy. (auth)

37859 MASS ESTIMATES OF SOME HEAVY HYPERFRAGMENTS. Prowse, D. J. (Univ. of California, Los Angeles); Nickols, N. A. Phys. Rev., 139: B544-6(Aug. 9, 1965).

Three events were found and analyzed which enable some quantitative estimates to be made of the mass of a decaying hyperfragment. These events were chosen in an unbiased way from a large number of double star interactions in nuclear emulsion initiated by mesons (K^-). Only those with a high visible energy in the secondary star coupled with a large momentum unbalance were selected. All three mass estimates would classify the hyperfragments as heavy and therefore confirm the existence of such hyperfragments. (auth)

37860 PROPERTIES OF THE CROSS SECTIONS FOR THE ^{32}S(γ,np)^{30}P, ^{40}Ca(γ,np)^{38}K, AND ^{66}Zn(γ,np)^{64}Cu REACTIONS FROM 50 TO 300 Mev. Van Hise, James R.; Meyer, Richard A.; Hummel, John P. (Univ. of Illinois, Urbana). Phys. Rev., 139: B554-62(Aug. 9, 1965).

Yield values for the ^{32}S(γ,np)^{30}P, ^{40}Ca(γ,np)^{38}K, and the ^{66}Zn(γ,np)^{64}Cu reactions were determined in the 50- to 300-Mev energy range. Targets of natural sulfur, calcium, and zinc were irradiated with bremsstrahlung from the University of Illinois 300-Mev betatron, and the product

yields were determined from measurements of their radioactivities with a gamma scintillation spectrometer. In order to extract cross-section information from the yield data, the $^{32}S(\gamma,np)^{30}P$ reaction yield data from threshold to 90 Mev reported by Bonazzola were normalized to these data and used to complete the yield curves near the reaction thresholds. Cross sections averaged over 30-Mev-wide energy bins were determined for the $^{32}S(\gamma,np)^{30}P$ reaction, but it was possible to determine only the behavior of integrated cross sections in the other two cases because of larger statistical uncertainties in the yield data. The previous work on the $^{32}S(\gamma,np)^{30}P$ reaction at energies below 90 Mev showed that the cross section peaks at a value of 4.3 mb at 28 Mev and then decreases at higher energies. The cross sections resulting from this work reach zero near 100 Mev and then rise, reaching a value of 1.0 mb near 220 Mev. The integrated cross section to 300 Mev is 190 ± 12 Mev mb. The integrated cross sections to 300 Mev for the $^{40}Ca(\gamma,np)^{38g}K$ and the $^{67}Zn(\gamma,np)^{66}Cu$ reactions are 88 ± 14 and 400 ± 60 Mev mb, respectively. Using the results of Stein on the number of coincident neutron-proton pairs observed from quasideuteron absorption processes in various nuclei, it is estimated that events associated with quasideuteron absorption processes account for 25% or less of the observed (γ,np) cross sections above 140 Mev. A mechanism in which a meson is produced and escapes from the nucleus, followed by a nuclear cascade and nucleon evaporation caused by the recoiling nucleon, can account reasonably well for the remainder of the observed cross sections. However, a sizeable contribution from processes in which a meson is reabsorbed can not be ruled out, because of the absence of detailed information about the fraction of the meson production events that leads to the (γ,np) product. (auth)

37861 ELECTRODISINTEGRATION OF NUCLEI BY POSITRONS AND ELECTRONS. Herring, D. F.; Nascimento, I. C.; Walton, R. B.; Sund, R. E. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev., 139: B562-6(Aug. 9, 1965).

The ratio σ^-/σ^+ of the cross sections for electrodisintegration of nuclei by electrons and positrons was measured at 27 Mev for target nuclei of ^{12}C, ^{63}Cu, ^{107}Ag, and ^{181}Ta. For ^{12}C and ^{107}Ag the ratio was measured as a function of energy in the region of the giant resonance. The ratio σ^-/σ^+ was determined from activities induced in thin foils which were bombarded by electrons and positrons from an electron linear accelerator. The measured ratio σ^-/σ^+ appears to vary linearly with Z and to be independent of energy in the range covered. The results may be used to estimate the extent to which the plane-wave theory of electrodisintegration fails because of the Coulomb distortion of the electron wave function. (auth)

37862 ANALYSIS OF THE SCATTERING OF 40-Mev PROTONS. Fricke, M. P. (Univ. of Minnesota, Minneapolis); Satchler, G. R. Phys. Rev., 139: B567-78(Aug. 9, 1965). (ORNL-P-1174).

The elastic and inelastic scattering of unpolarized 40-Mev protons from ^{12}C, ^{54}Fe, ^{56}Fe, ^{58}Ni, ^{60}Ni, and ^{208}Pb was analyzed using the optical-model potential and its collective-model extension in the distorted-wave approximation. Fits to the inelastic scattering from ^{24}Mg and to the elastic scattering from ^{27}Al, ^{65}Cu, Sn, and ^{181}Ta also are included. The Woods-Saxon shape parameters for the potential differ from those suggested for scattering at lower energies, and either surface or volume forms of the imaginary part produce good agreement with the data. To describe the inelastic scattering best, it is found necessary to deform the imaginary (as well as the real) part of the central potential. The deformation parameters obtained are in reasonable agreement with those found by other methods. (auth)

37863 NUCLEAR-STRUCTURE STUDIES IN THE NICKEL ISOTOPES WITH (d,t) REACTIONS. Fulmer, R. H.; Daehnick, W. W. (Univ. of Pittsburgh). Phys. Rev., 139: B579-92(Aug. 9, 1965).

Nuclear levels of the nickel isotopes were investigated with (d,t) reactions at 15-Mev deuteron energy. Absolute differential cross sections were obtained from isotropically enriched ^{58}Ni, ^{60}Ni, ^{61}Ni, ^{62}Ni, and ^{64}Ni targets with ΔE-x-E counter telescope and two-parameter multichannel analysis. Two sets of distorted-wave Born approximation (DWBA) calculations were made for all Q values and l values of interest, and spectroscopic factors and l values were extracted from the comparison of data and theory. In addition, a number of j values, for the final states, were assigned on the basis of empirical rules. A j dependence was observed for all l = 1 and l = 3 transitions where resolution and statistics were good enough to allow analysis of the data for angles larger than about 45°. For all but the very weakly excited levels, correct j values could also be obtained from a comparison of (d,p) and (d,t) spectroscopic factors leading to the same final state. It was noted that a number of l = 3 transitions previously observed by Cohen, Fulmer, and McCarthy in Ni(d,p) reactions led to final states that were found to be $f_{\frac{7}{2}}$. This indicates that in the light Ni isotopes the $f_{\frac{7}{2}}$ shell is not completely filled. The spectroscopic factors reported are discussed in terms of the shell-model pairing theory by Kisslinger and Sorensen. The results for the energies and fullness of single-quasiparticle levels are in agreement with results from (d,p) work provided the correct j assignments are used. It was found that all DWBA predictions without l·s interaction failed to give good quantitative agreement with the observed (d,t) angular distributions for angles beyond the stripping peak. DWBA calculations were made for a conventional neutron form factor which is determined by the neutron separation energy, and also for a recently suggested form factor which is determined by a constant binding energy for all neutrons with a given j, regardless of differences in separation energy. The two form factors lead to almost identical predictions for the angular distributions; however, systematic differences are found in the spectroscopic factors. In terms of shell-model expectations, the conventional approximation for the neutron form factor leads to more consistent results. (auth)

37864 α PARTICLES FROM THE TRITON BOMBARDMENT OF ^7Li, ^{12}C, AND ^{16}O. Ajzenberg-Selove, F. (Haverford Coll., Penna.); Watson, J. W.; Middleton, R. Phys. Rev., 139: B592-6(Aug. 9, 1965).

A ^7Li oxide layer deposited on a carbon foil was bombarded by 13-Mev tritons from the Aldermaston tandem accelerator. The spectra of α particles emitted at 24 angles relative to the incident beam (5 to 175°) were determined with the Aldermaston multigap spectrograph, using nuclear plates as detectors. The first excited state of ^6He is found to have an excitation energy of 1.797 ± 0.025 Mev and a width of 113 ± 20 kev. No other excited states of ^6He below an excitation energy of 12 Mev were observed, for $\theta = 5$ to 35°. Angular distributions of alpha particles were determined to the following states: $E_x = 0$ and 1.80 Mev in ^6He; $E_x = 0$, 5.28 + 5.31, and 6.33 Mev in ^{15}N; $E_x = 0$, 2.14, 4.46, and 5.03 Mev in ^{11}B. The angular distributions show strong direct-interaction features. (auth)

37865 ASYMMETRY OF (d,p) CROSS SECTION FOR POLARIZED He^3 TARGET. Tanifuji, Makoto (Rice Univ., Houston, Tex.). Phys. Rev. Letters, 15: 113-14 (July 19, 1965). (TID-21959)

The left-right hand asymmetry for the $^3He(d,p)^4He$ reaction using a polarized helium-3 target is discussed. Proton-target-nucleus and proton-final-nucleus interactions were investigated under the direct-reaction assumption. The relation between the proton-spin polarization for an unpolarized target and left-hand asymmetry for a polarized target was then calculated. (J.F.P.)

37866 REACTION $He^3(d,p)He^4$ WITH A POLARIZED TARGET. Baker, S. D.; Roy, G.; Phillips, G. C.; Walters, G. K. (Rice Univ., Houston, Tex.). Phys. Rev. Letters, 15: 115-16(July 19, 1965). (TID-21958)

New data are reported on the reaction $^3He(d,p)^4He$ using a polarized helium-3 target. The preliminary results show that such measurements provide significant information

concerning direct-interaction mechanisms. It appears that conventional calculations of polarization in stripping reactions should be re-examined. (J.F.P.)

37867 SUPERCONDUCTIVITY IN FILMS OF BETA TUNGSTEN AND OTHER TRANSITION METALS. Bond, W. L.; Cooper, A. S.; Andres, K.; Hull, G. W.; Geballe, T. H.; Matthias, B. T. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 15: 260-1(Aug. 9, 1965).

The discovery of superconductivity in tungsten films which contain the β-W structure is reported. Transition temperatures as high as 3.35°K were observed in these films which are more than two orders of magnitude higher than that reported for bulk tungsten. Films of a series of transition-metal elements were studied. Thicknesses of about 1000Å are normally deposited on glass or sapphire substrates by electron-bombardment evaporation. The superconductivity is easily detected. In tungsten, rhenium, and molybdenum the transition temperatures are found to be considerably higher than those of the bulk metals. In these cases there is x-ray evidence for the presence of a phase other than the normal metal. The very high superconductivity observed in these metals is believed to be due to this other phase composed largely of the element in question but probably stabilized by an impurity. (J.F.P.)

37868 SPIN-SPIN INTERACTION AND THE REACTION $^{18}O(p,n)^{18}F$. Bloom, S. D.; Anderson, J. D.; Hornyak, W. F.; Wong, C. (Univ. of California, Livermore). Phys. Rev. Letters, 15: 264-6(Aug. 9, 1965). (UCRL-14172)

In the direct (p,n) reaction on T = 1 nuclei such as carbon-14, oxygen-18, and neon-22, a unique possibility exists for detecting the spin-exchange process occurring simultaneously with the isospin (charge) exchange process via the $V_{\sigma\tau}$ two-body potential. While $V_{\sigma\tau}$ can and will cause the transition from the ground state in the initial nucleus to the ground state in the final nucleus, the simple charge-exchange potential V_τ cannot. But only V_τ will bring about the quasielastic (p,n) process. Thus a comparison of the cross sections to these two final states can give an estimate of the relative strength of $V_{\sigma\tau}$ and V_τ. The reaction $^{18}O(p,n)^{18}F$ was used for these measurements. The results showed evidence for a direct reaction mechanism. It is clear that $V_{\sigma\tau}$ is not only nonzero, but is comparable in magnitude with V_τ. In addition to this evidence, the effects of spin-exchange can also be deduced from the ratio of the quasielastic cross sections for ^{17}O and ^{18}O. (J.F.P.)

37869 MEASUREMENT OF THE LIFETIMES OF SOME EXCITED STATES OF ^{192}Pt. Butt, D. K.; Jackson, D. A. (London Univ.). Proc. Phys. Soc. (London), 86: 31-8(July 1965).

The lifetimes of the 316.5-612.4-and 920.8-kev levels of ^{192}Pt, produced in the decay of ^{192}Ir, were studied by the method of K electron-K electron coincidence centroid shift. The mean life of the 612.4-kev level was measured to be $3.4 \pm 1.9 \times 10^{-11}$ sec, and upper limits of 4.2×10^{-11} and 3.5×10^{-11} sec were placed on the mean lives of the 316.5- and 920.8-kev levels, respectively. (auth)

37870 NUCLEAR MAGNETIC MOMENT RATIOS MEASURED IN HIGH AND LOW FIELDS. Huggins, R. W.; Sanders, J. H. (Oxford Univ.). Proc. Phys. Soc. (London), 86: 53-63(July 1965).

Recent measurements of the gyromagnetic ratio of the proton have yielded results which indicate that there may be a field dependence of the magnetic moment of the proton. An attempt was made to observe such a dependence; although none was found, a method of comparing nuclear magnetic resonance frequencies with a precision of better than 1 part in 10^6 is described. The ratio of the proton resonance frequency to the resonance frequencies of ^3H, ^7Li, ^{11}B, ^{19}F were measured to a precision which is in some cases as high as 1 part in 10^7. (auth)

37871 ISOLATION AND IDENTIFICATION OF 12.4-MINUTE ^{133g}Te. Prussin, Stanley G.; Meinke, W. Wayne (Univ. of Michigan, Ann Arbor). Radiochim. Acta, 4: 79-82(June 1965).

A radiochemical extraction procedure for the separation of tellurium isomers was used to isolate an activity with a 12.45 ± 0.28 min half life growing into samples of fission tellurium. This activity was assigned to the ground state of ^{133}Te as it is shown to arise in the decay of the 54-min component present in the fission-product tellurium and to decay to form the 21-hr ^{133}I. The gamma spectrum of ^{133g}Te showed prominent photopeaks at 0.307 ± 0.01, 0.406 ± 0.01, 1.335 ± 0.01, 1.709 ± 0.02, and ≈ 1.85 Mev. (auth)

37872 FISSION CROSS-SECTION OF BISMUTH FOR 14.8 Mev NEUTRONS. Ganapathy, R.; Meason, J. L. (Univ. of Arkansas, Fayetteville). Radiochim. Acta, 4: 113-14(June 1965).

A 136-gram sample of reagent grade bismuth nitrate was irradiated with 14.8 ± 0.2-Mev neutrons produced by the $T(d,n)^4He$ reaction. The neutron flux was estimated by sandwiching the target material between aluminum monitors. The decay of ^{105}Ru, isolated from the entire sample of irradiated bismuth nitrate, was fitted to the experimental points using the reported half life of 4.5 hrs. Extrapolating the activity of ^{105}Ru to the end of irradiation, it was found to be $(4.41 \pm 0.58) \times 10^{-3}$ counts per sec. The cross-section for 14.8 Mev neutron-induced fission of bismuth was calculated. (F.J.H.)

37873 NUCLEAR FISSION. Leachman, R. B. Sci. Am., 213: No. 2, 49-56; 59(Aug. 1965).

The description of fission by the liquid-drop analogy is briefly discussed, with consideration of shell effects as observed in the fission of uranium. (D.C.W.)

37874 A NUCLEON-PHONON HAMILTONIAN FOR SPHERICAL NUCLEI. Belyaev, S. T. Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 3-9(July, 1965).

Translated from Yadern. Fiz., 1: 3-12(Jan. 1965).

By the use of the Green's function method, a model Hamiltonian, containing nucleons and collective excitations (phonons), is derived for the model of a spherical nucleus with a simple residual interaction of the nucleons(Cooper pairing plus quadrupole interaction). The distortion of the phonon propagator and of the nucleon-phonon vertex part when other types of interactions are switched on is investigated. The use of a nucleon-phonon Hamiltonian decidedly simplifies the study of many-particle correlations in spherical nuclei. (auth)

37875 ON THE ENERGY SPECTRA OF ODD SPHERICAL NUCLEI. Belyaev, S. T.; Zelevinskii, V. G. Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 10-18(July 1965).

Translated from Yadern. Fiz., 1: 13-26(Jan. 1965).

Since the low excited states of spherical even-even nuclei can be described with sufficient accuracy by their collective motion, the excitations of odd-A spherical nuclei are studied, theoretically assuming that the basic interaction is that of the odd nucleon with collective excitations of the even core (phonons). Such an assumption is justified for adiabatic collective excitations. The phonon-nucleon interaction is not considered weak. Such a microscopic study (with a limited number of arbitrary constants) is of considerable importance since during the usual semiempirical comparison of the model with the experimental results, the number of arbitrary parameters coincides with the number of experimental facts and, consequently, the applicability of the model seems not to be based on sufficiently firm grounds. In some limiting cases, analytic expressions for the Green functions are found in the form of sums over an infinite number of pole terms. Physical consequences of the nucleon-phonon interactions in odd-A nuclei are discussed (isomeric level shift, quadrupole and magnetic nuclear moments, electromagnetic transition probabilities), and it is concluded that one must be particularly careful when using the one-particle Green's function of the Fermi-liquid theory (containing only a single pole component) in place of the exact one-nucleon nuclear function. (CFSTI)

37876 THE INTERACTION OF BETA AND GAMMA BANDS IN DEFORMED NUCLEI. Lomonosov, V. V.; Urin,

M. G. (Moscow Engineering Physics Inst.). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 22-5(July 1965).

Translated from Yadern. Fiz., 1: 32-7(Jan. 1965).

The vibration-rotational interaction of the rotational bands, connected with the beta and gamma vibrational levels in deformed nuclei, is investigated. The corresponding vibration-rotational interaction parameter is estimated within the framework of a model in which pairing and quadrupole interaction between nucleons is taken into account. For this estimate it is necessary to take the nonadiabatic vibrations into account. The results of calculations performed in the quasi-classical approximation are compared with experimental data. (auth)

37877 ISOTOPIC SHIFT AND QUADRUPOLE MOMENTS OF NEAR-SPHERICAL NUCLEI. Bunatyan, G. G.; Mikulinskii, M. A. Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 26-30(July 1965).

Translated from Yadern. Fiz., 1: 38-45(Jan. 1965).

The isotopic shift of electron energy levels and the quadrupole moments of nuclei in the vicinity of spherical nuclei were calculated on the basis of the theory of finite Fermi systems developed by Migdal. An analysis of the phenomena led to the conclusion that it is necessary to introduce an interaction amplitude which changes its sign and magnitude at the surface of the nucleus. The values of the internal and external constants of the theory have been also determined. (CFSTI)

37878 EFFECT OF NONMONOCHROMATICITY IN MEASUREMENTS OF THE CROSS SECTION FOR GAMMA QUANTUM ABSORPTION BY LIGHT NUCLEI. Danilyan, G. V. (Inst. of Theoretical and Experimental Physics, USSR). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 31(July 1965).

Translated from Yadern. Fiz., 1: 46-7(Jan. 1965).

It is shown that the integral gamma absorption cross sections for light nuclei in the giant resonance region obtained by measuring the total cross section using the transmission method are lower than their true values in the case of relatively poor resolution and a thick sample. This is due to the fact that the calculations do not take into account the nonmonochromaticity of the radiation during resonant absorption. (CFSTI)

37879 ELASTIC SCATTERING OF LOW-ENERGY PROTONS BY ISOTOPES OF CHROMIUM, IRON, NICKEL AND COBALT. Golovnya, V. Ya.; Klyucharev, A. P.; Shilyaev, B. A.; Shlyakhov, N. A. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 32-6(July 1965).

Translated from Yadern. Fiz., 1: 48-54(Jan. 1965).

The angular distributions of protons elastically scattered by ^{50}Cr, ^{52}Cr, ^{53}Cr, ^{54}Cr, ^{54}Fe, ^{56}Te, ^{58}Ni, ^{60}Ni, ^{62}Ni, ^{64}Ni, and ^{59}Co at 3.00 to 3.56 Mev were investigated in the region from 40 to 90°. The results show that the angular distributions in this range of angles are very sensitive to the structure of the nuclear surface. The nuclear interaction radii calculated in the quasiclassical approximation from the experimental data do not vary monotonically with the mass number. The observed dependence can be connected with the filling of the nucleon shells in the nuclei studied. (auth)

37880 ^{3}He-LIGHT NUCLEUS INTERACTION CROSS SECTIONS. Brill, O. D. Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 37-40(July 1965).

Translated from Yadern. Fiz., 1: 55-60(Jan. 1965).

The excitation functions of (He-3, α), (He-3, 2α), (He-3, d), (He-3, n), and other reactions of 30-Mev ^{3}He ions with light nuclei were obtained by the stacked-foil technique. The large (He-3, α) cross sections in ^{12}C and ^{16}O can apparently be accounted for by the contribution of a knock-out mechanism. (auth)

37881 SPONTANEOUSLY FISSILE ISOMER WITH 0.9-Msec HALF LIFE. Lobanov, Yu. V.; Kuznetsov, V. I.; Perelygin, V. P.; Polikanov, S. M.; Oganesyan, Yu. Ts.; Flerov, G. N. (Joint Inst. for Nuclear Research, USSR). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 45-7 (July 1965).

Translated from Yadern. Fiz., 1: 67-71(Jan. 1965).

In the bombardment of Pu and U by B and Ne ions accelerated in a 310-cm cyclotron, a spontaneously fissile isomer was found with $Z \leq 99$ and a half life of 0.85 msec. Glass detectors were used to record the spontaneous fission fragments. (auth)

37882 UPPER LIMIT OF THE CROSS SECTION FOR COHERENT INTERACTIONS OF π^- MESONS WITH HEAVY EMULSION NUCLEI. Azimov, S. A.; Beter, E. V.; Gulyamov, U. G. Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 48-50(July 1965).

Translated from Yadern. Fiz., 1: 72-5(Jan. 1965).

A method is proposed for selecting events of coherent production of two mesons (π) from a nucleus by a high-energy meson (π). The method is based on information obtained from angular measurements only. The upper limit of the cross section is estimated for the process on heavy emulsion nuclei when the momentum of the primary mesons (π^-) is 17.2 Bev/c. (auth)

37883 ^{8}Li PRODUCTION IN DISINTEGRATIONS OF ^{12}C NUCLEI BY HIGH-ENERGY PROTONS. Afanas'eva, R. V.; Lozhkin, O. V.; Mal'tsev, V. M.; Yakovlev, Yu. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Soviet J. Nucl. Phys. (English Transl.), 1: No. 1, 51-3(July 1965).

Translated from Yadern. Fiz., 1: 76-9(Jan. 1965).

A fragmentation model is treated under the hypothesis of inelastic reactions between the primary proton and a cluster in the nucleus. ^{8}Li production by high-energy protons in ^{12}C disintegrations is used as an example. This model is shown to describe the experimental data without a special choice of parameters. (auth)

37884 ELASTIC SCATTERING OF NEUTRONS OF 0.8 Mev ENERGY AND THE OPTICAL MODEL OF THE NUCLEUS. Korzh, I. A.; Kashuba, I. E. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 10: 586-96(June 1965). (In Ukrainian)

Results are given of calculations of angular distributions of elastically scattered neutrons with energy 0.8 Mev by nuclei of Na, Mg, Al, Si, Cr, Fe, Ni, Cu, Zn, Se, Zr, Mo, Cd, Sn, Sb, Te, Ba, W, Hg, Pb, Bi, and U. The optical potential with surface absorption and a real spin-orbital part, characterized by six independent parameters V_c, W_c, V_{so}, a, b, and $R = r_0 A^{1/3}$ was used in the calculations. It is shown that a small variation of V_c and W_c may give satisfactory agreement of theory with experiment. It was found that with the given potential form the angular distribution curves do not practically differ under the condition $W_c b$ = const. (auth)

37885 INVESTIGATION OF THE TYPE OF β INTERACTION IN THE β DECAY OF ^{23}Ne. Kartashov, G. R.; Burgov, N. A.; Davydov, A. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 1: 733-7 (May 1965). (In Russian)

The type of interaction in the beta decay of ^{23}Ne was determined by investigating the dependence of the cross section for the resonance absorption of gamma rays on the angle between the electrons and gamma-quanta in one and the same cascade. It follows from the resonance absorption curve that the decay is caused by the axial-type interaction. The experimental errors make it impossible to exclude a possible 20% admixture of the tensor interaction. (auth)

37886 LIFETIME OF THE 2^+ (603 Kev) LEVEL IN ^{124}Te. Akkerman, A. F.; Kochetkov, V. L.; Chekanov, V. N. (Inst. of Nuclear Physics, Kazkh SSR). Yadern. Fiz., 1: 738-43(May 1965). (In Russian)

The lifetime of the first excited state in ^{124}Te was measured, using the resonance scattering of gamma quanta. The influence of the chemical binding of the ^{124}Sb atom in the SbI_3 molecule on the microspectrum was investigated, together with the effect of the angular correlation of particles in the cascades. The result τ (603 kev) = $(6.9 \pm 0.9)\ 10^{-12}$ sec obtained in this investigation is compared with calculations according to the pair correlation model. (auth)

37887 QUADRUPOLE MOMENTS OF ODD SPHERICAL NUCLEI. Belyakov, V. A.; Khudyakov, S. V. Yadern Fiz., 1: 744-51(May 1965). (In Russian)

The quadrupole moments of a large number of odd spherical nuclei are calculated on the basis of the finite Fermi-system theory. (auth)

37888 ELECTROMAGNETIC TRANSITIONS FROM COLLECTIVE STATES. Fogel, P. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 752-7 (May 1965). (In Russian)

The reduced probabilities of E3, E2 and E1 type electromagnetic transitions are obtained, on the basis of the approximate second quantization method, in the superfluid model of the atomic nucleus. The values B(E2) are calculated for transitions between gamma vibrational and ground states, and B(E3), and B(E1) are calculated for octupole states. The application of the model for E2 and E0 transitions from beta vibrational states is discussed. A comparison with experiments shows that this model gives a good explanation of the experimental data on transitions between one-phonon states and the phonon vacuum. (auth)

37889 UNIFIED THEORY OF NUCLEAR RESONANCE REACTIONS. PARTIAL REACTION CROSS SECTIONS. Gordeev, I. V. (All-Union Scientific-Research Inst. of Physico-Technical and Radiotechnical Measurements, USSR). Yadern. Fiz., 1: 785-92(May 1965). (In Russian)

An attempt is made to take into account the imaginary terms of the effective hamiltonian for the system of a nucleus plus a neutron, causing the transition of a neutron from a single-particle state to a compound nucleus, in all the open reaction channels. An explicit expression for the average cross section of the partial reaction is obtained. (auth)

37890 GAMMA RADIATION IN THE INELASTIC INTERACTION OF 14-Mev NEUTRONS WITH MAGNESIUM, ALUMINIUM, AND SULPHUR NUCLEI. Bochkarev, V. N.; Nefedov, V. V. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 1: 803-8(May 1965). (In Russian)

The energies and differential cross sections of gamma transitions were measured in magnesium, aluminium and sulphur. An estimation of the cross section of the reaction $^{24}Mg(n,\alpha)^{21}Ne$ is obtained. (auth)

37891 NEUTRON PRODUCTION IN THE INTERACTION OF TRITONS WITH BORON NUCLEI. Vatset, P. I.; Kolesnikov, L. Ya.; Tonapetyan, S. G. Yadern. Fiz., 1: 809-11 (May 1965). (In Russian)

The dependence of the cross section for the production of neutrons at 0° on the triton energy was investigated in the the energy region from 0.54 to 2.4 Mev for boron nuclei of the natural isotopic composition. Ten resonances were found, corresponding to the following excited states of the ^{14}C nucleus: 21.53; 21.64; 21.82; 21.89; 21.93; 22.00; 22.11; 22.20; 22.35; 22.41 Mev. (auth)

37892 A PROTON EMITTER PRODUCT OF THE Ru + O^{16} REACTION. Karnaukhov, V. A.; Ter-Akop'yan, G. M.; Petrov, L. A.; Subbotin, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 812-15(May 1965). (In Russian)

A Ru target was irradiated with ^{16}O ions at 70 to 90 Mev. Two proton emitters with the half lives 60 ± 10 sec and 11 ± 2 sec were detected among the products of the nuclear reactions. The proton energy spectrum consists of a number of lines in the region from 2 to 4.5 Mev. So far it has not proved possible to separate them. Preliminary experiments make it possible to identify with high probability the 11-sec emitter as a Te isotope with a mass number of 109 or 111. (auth)

37893 KINETIC ENERGY OF FRAGMENTS AND THE ENERGY BALANCE IN THE THERMAL NEUTRON FISSION OF ^{235}U. Apalin, V.; Pritsyuk, Yu.; Kutikov, I.; Lebedev, V.; Mikaelyan, L. Yadern. Fiz., 1: 816-20 (May 1965). (In Russian)

The distribution of the total kinetic energy of additional fragments was measured as a function of their mass ratio, using a gas ionization chamber. A value of 21 Mev was obtained for the difference between the average kinetic energy in symmetrical fission and in fission in which the heavy fragments are magical ($M_H = 130 - 132$). The ratio of the maximum and minimum of the (final) fragment yield curve in symmetrical fission proved to be approximately equal to 500:1. The total energy release found from the experimental data is in good agreement with calculations according to the semiempirical Weizsäcker formula, except for regions of strongly asymmetrical fission. (auth)

37894 THE FORM OF THE FISSIONING NUCLEUS AT THE SADDLE POINT AND THE LIQUID DROP NUCLEAR MODEL. Strutinskii, V. M. Yadern. Fiz., 1: 821-5(May 1965). (In Russian)

It is shown that the effective moment of inertia of a fissioning nucleus, determined from the angular anisotropy of fission products, is in good agreement with the value calculated for the saddle point with the help of the liquid-drop model, taking the diffuse nuclear boundary into account. (auth)

37895 INVESTIGATION OF SECONDARY REACTIONS IN THE BOMBARDMENT OF COPPER BY PROTONS IN THE ENERGY REGION 140 TO 660 Mev. Mekhedov, V. N.; Rybakov, V. N.; Mal'tseva, N. S.; Makarov, S. P.; Wang, Ch'uan-peng (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 1: 826-31(May 1965). (In Russian)

The formation probabilities of a number of neutron-deficient gallium, germanium, arsenic, and selenium isotopes, obtained in secondary reactions in the bombardment of copper by 140 to 660-Mev protons, were measured, using a radiochemical method. The measured yields of the (α, xn), (Li, xn), and (Be, xn) reactions lie between 3.3×10^{-29} cm^2 and 1.0×10^{-33} cm^2. Their absolute values and energy dependences are in good agreement with results on secondary reactions given in the literature. A neutron-excessive isotope of ^{67}Cu was discovered. The probability of its formation at small energies is 0.3×10^{-30} cm^2 and increases four times for the maximum proton energies used. The investigation proves that there is no serious difference between the behavior of secondary reactions on copper and in the irradiation of heavier elements by protons. (auth)

37896 CAPTURE OF NEGATIVE MUONS BY ATOMS IN CHEMICAL COMPOUNDS. Bobrov, V. D.; Varlamov, V. G.; Grashin, Yu. M.; Dolgoshein, B. A.; Kirillov-Ugryumov, V. G.; Roganov, V. S.; Samoilov, A. V.; Somov, S. V. (Inst of Physics and Engineering, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 1197-9(Apr. 1965). (In Russian)

The relative probabilities of meson (μ^-) capture by atoms in several chemical compounds were measured with the aim of extracting information necessary for the interpretation of other experiments with muons. The results show that for the compounds investigated (LiCl, CsCl, ZnO, ZnS, and AlCu) the Fermi-Teller Z-law does not describe the experiment satisfactorily. An analysis of the available data shows that compared with the prediction of the Z-law, mesic atoms of the elements which have relatively large electron-affinity energy are produced with some preference. The results show that in most cases the tendency to preferred formation of the mesic atoms of the element with the larger electron affinity is violated only in five of 31 cases. Four out of the five violations are in compounds of carbon, and this is apparently connected with very complicated spatial configuration of these molecules. (ATD)

37897 CAPTURE OF NEGATIVE MUONS BY PURE CHROMIUM AND NICKEL ISOTOPES. Bobrov, V. D.; Varlamov, V. G.; Grashin, Yu. M.; Dolgoshein, B. A.; Kirillov-Ugryumov, V. G.; Roganov, V. S.; Samoilov, A. V.; Somov, S. V. (Inst. of Physics and Engineering, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 1199(Apr. 1965). (In Russian)

Since data on muon capture by nuclei can be used as a

tool for the study of the structure of the nucleus, muon capture by nuclei with closed neutron or proton subshells, in the form of isotopes of Cr with mass numbers 50, 52, 53, and 54 (^{52}Cr has a closed neutron subshell) and Ni isotopes with mass numbers 58, 60, and 62 (which have a closed proton subshell) was investigated. The isotope enrichment runs from 78.5 to 99.5%. The muon beam from the OIYaI synchrocyclotron was used for the experiments. The total muon capture probability was determined by measuring the lifetimes of the muons on the K orbit of the corresponding atom. (ATD)

37898 ANNIHILATION OF POLARIZED POSITRONS IN NICKEL. Sedov, V. L. (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 48: 1200-1(Apr. 1965). (In Russian)

The variations of the angular distribution of annihilation γ-quantum pairs were measured for the purpose of ascertaining the polarization of different electron groups from the change in the angular distribution of the γ-quantum pairs. The measurements were made with nickel. The measurement procedure was essentially the same as described by J. Lovas (Nucl. Phys., 17: 279(1960)). The geometry of the apparatus was such, however, that the integral distribution of the annihilation quanta was measured. The analysis of the results shows definitely that in nickel the 4s electrons are polarized antiparallel to the 3d electrons. (ATD)

37899 DIFFRACTION SCATTERING AND REGGE POLES. Inopin, E. V. Zh. Eksperim. i Teor. Fiz., 48: 1620-4(June 1965). (In Russian)

The cross section for diffraction scattering of particles on a black nucleus is obtained by the complex angular momentum method. The expression for the cross section takes into account smearing out of the boundary of the nucleus and some other factors which are neglected in the ordinary diffraction theory. Comparison with results on scattering of alpha particles by ^{24}Mg nuclei supports the theory. (auth)

37900 ELECTROMAGNETIC STRUCTURE OF THE GIANT DIPOLE RESONANCE. Lewis, Francis Hotchkiss Jr. Thesis, Stanford, Calif., Stanford Univ., 1964. 172p.

The transverse inelastic form factor for electromagnetic excitation of the giant resonance is discussed and calculated on the basis of several different models. Particular attention is paid to the particle-hole theory of the giant resonance, which is reformulated in such a way as to avoid the usual self-consistency questions and no free parameters are left over, i.e., all parameters are determined from other experiments. The extension of the theory to take into account ground state correlations is formulated in terms of the random phase approximation and the usual eigenvalue equations are derived. Numerical calculations are carried out both for ^{12}C and ^{16}O and compared with the 180° electron scattering experiments and with photoabsorption and radiative proton capture data. It is found that the particle-hole theory successfully predicts the main features of the giant resonance such as the dip in the squared form factor and the shifting of the resonance peak energy as the momentum transfer is changed, both of which are observed experimentally in both ^{12}C and ^{16}O, and neither of which is predicted by the Goldhaber-Teller or Steinwedel-Jensen collective motion models. Further comparison between the theory and the experimental data allows a distinction between variations in some of the more detailed features of the particle-hole theory, and it is found that the model with no free parameters yields results that are consistent with all of the experimental data considered. The corrections due to correlations in the ground state are also seen to produce no significant changes in the main features of the theory. Results for all of the models considered are presented and discussed. (Dissertation Abstr.)

37901 THE (n,2n) REACTION ON DEUTERIUM. Koehler, Dale Roland. Thesis, Tuscaloosa, Ala., Univ. of Alabama, 1964. 61p.

The D(n,2n)p reaction is treated in a direct interaction framework wherein the phenomenological nucleon-nucleon potentials of Gammel and Thaler are used to describe the perturbation interactions. Tensor forces as well as central forces are included and final state interactions among the particles is considered. The final state is pictured as a continuum deuteron plus free neutron or as a continuum dineutron plus free proton. To the extent that this picture is accurate, it is found that the main contributions to the cross section are supplied by the doublet to doublet transitions. The calculations furthermore suggest a "best choice" for the triplet–even parity–central potential. A comparison with the experimental results of Ilakovac and coworkers at 14.4 Mev is presented. (Dissertation Abstr.)

37902 FORTRAN PROGRAMMES FOR γ SPECTRA ANALYSIS AND FOR NUCLEAR RESONANCE ANALYSIS. Mani, G. S. (Physical Research Labs., Manchester, Eng.); Freeman, R. pp 540-6 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

A FORTRAN program for analyzing complex spectra is described. The program has been written for IBM 7090 computer and uses an automatic search routine for unfolding gamma spectra. The photo peaks are assumed to be Gaussian in shape and the Compton edge is reproduced approximately by an analytical formula. The background is assumed to be exponential in form. The program takes less than a minute to fit a spectrum and a modified form even takes less than 15 seconds. A FORTRAN program for resonance analysis is also described which can fit the integrated cross-section as well as angular distribution simultaneously using an automatic search routine to obtain the resonance parameters. The program can be used for the case of the many level formula or for the multilevel formula. In the case of many level formula it can handle as many as ten resonances while in the case of the multilevel formula it can handle up to three resonances. (auth)

37903 GREEN'S FUNCTION AS A QUANTITATIVE TOOL IN NUCLEAR THEORY. Migdal, A. B. pp 475-500 of Voprosy Fiziki Elementarnykh Chastits. Erevan, Publishing House of Academy of Sciences, 1964. (In Russian)

Although all of the most interesting nuclear effects were studied qualitatively within the framework of simple physical models, general quantitative results can be obtained only from a more unified treatment because the interaction between the nucleons is far from weak. The Green's function method represents such an approach; it yields the totality of graphs which vary slowly near the Fermi limit, and in the case of small excitations they can be replaced by constants. Such an approach was first carried out by Landau in his theory of Fermi liquids; further extensions to the case of two types of fermions and a superfluid Fermi system were made by Migdal, Lushnikoff, and Zaretsky. In the case of finite systems, the reaction to external fields reduces to the behavior of a gas of interacting quasi-particles in a potential well. It suffices to take into account only binary collisions since multiple collisions lead only to a renormalization of the interaction between quasi-particles and to the appearance of an effective charge of particles interacting with the external field. This effective charge can in most cases be found from general considerations (gauge invariance or conservation laws). In the nuclear case, the effective (local) interaction is characterized by a number of constants which are the same for all nuclei and all types of transitions; their constancy is directly proportional to the constancy of the mass density of the nuclear matter. These constants are taken from experiments since their calculation is impossible without recourse to approximate methods. However, once they are introduced, the theory is able to interconnect a wide range of diverse effects; the width and position of the maximum of the dipole resonance curve can be expressed through the symmetry average in the Weizsacker nuclear mass formula. The theory is specifically used for the justification of the shell model, description in the Green's function language of multibody systems, discussion of the case of nuclei within external fields and of the equation of the effective field within the nucleus, derivation of the effective field in

the case of pair-wise correlation, and formulation of interactions between quasi-particles. Deductions from experimental data concerning interaction amplitudes, stability conditions for nuclear matter, lack of need for quadrupole-quadrupole interactions within nuclei, changes in the density matrix as functions of the number of particles added, changes of the density matrix in strong fields, quantum jumps in the radius and shape of the nucleus, shifts in nuclear boundaries during excitation and addition of particles, magnetic moments, moments of inertia, transition probabilities, and the dipole photoeffect are also discussed. Future tasks of the theory include the explanation of irregular changes in β-transition intensities, description of K and μ captures, explanation of the detailed fluctuations in binding energy, calculations of the corrections due to nucleon interactions for high-energy electron scattering, and the evaluation of the frequencies and intensities of collective transitions. (JPRS)

37904 ELASTIC AND INELASTIC ELECTRON SCATTERING FROM ^{12}C AND ^{16}O. Crannell, Hall Leinster. Thesis, Stanford, Calif., Stanford Univ., 1964. 157p.

Elastic and inelastic scattering of electrons from ^{12}C and ^{16}O were studied for various scattered electron angles, using primary electron energies from 187 to 800 Mev. The studies cover a range of q^2 values from 0.75 F^{-2} to 11.45 F^{-2} for ^{12}C, and from 2.79 F^{-2} to 8.52 F^{-2} for ^{16}O. With the resolution obtained in this experiment, it is possible to separate elastically scattered electrons from those scattered inelastically. Inelastic electron scattering, resulting in excitation of nuclear levels, is observed for the 4.43-Mev, 7.65-Mev, and 9.64-Mev levels in ^{12}C; and for the 6.1-Mev levels in ^{16}O. A highly excited level at approximately 19 Mev is also observed in ^{12}C. A procedure for subtracting the effects of energy loss due to radiation of protons is developed. A computer program was constructed, which enables the original data to be corrected automatically for the effects of counting rate losses, counter efficiency, and radiative losses. The data are then automatically plotted. Differential cross sections for excitation of nuclear levels are measured. Elastic scattering cross sections are also determined. No second diffraction minimum in the elastic scattering data was observed from either ^{12}C or ^{16}O, even at the highest momentum transfers studied. However, at the highest energies and angles, a diffraction feature in the cross sections for excitation of the 4.43-Mev level in ^{12}C is observed for the first time. Analyses of the data using first Born approximation show that: (1) the harmonic well model provides a reasonable fit to the new elastic scattering data, (2) the depression of the central charge density may be slightly less than that predicted by the harmonic well model, and (3) the harmonic well model root-mean-square radii of ^{12}C and ^{16}O are 2.41 ± 0.03 F and 2.75 ± 0.03 F, respectively. A method of analysis, which depends only upon the validity of first Born approximation at low momentum transfers, is presented for determining the multipolarity and transition widths of excited states in nuclei. The transition widths of the three lowest excited states in ^{12}C are found to be $(14.3 \pm 3.6) \times 10^{-3}$ ev for the 4.43-Mev level, $(1.7 \pm 0.4) \times 10^{-3}$ ev for the 7.65-Mev level, and $(5.7 \pm 2.0) \times 10^{-3}$ ev for the 9.65-Mev level. (Dissertation Abstr.)

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Refer also to abstracts 36777 and 37485.

37905 (AD-426186) STUDIES IN ELECTROMAGNETIC WAVE INTERACTION TECHNIQUES. Final Report. Narasinga Rao, K. V.; Goldstein, L. (Illinois Univ., Urbana. Gaseous Electronics Lab.). Oct. 1963. Contract AF19(604)-3481. 27p. (AFCRL-63-737). $2.60(CFSTI).

The technique of interaction of guided electromagnetic waves in magnetoplasmas is utilized to study the phenomena resulting from the cyclotron resonance (f = fH = gyrofrequency of electrons) absorption of microwave energy by the electron gas. The enhancement in electronic energy caused by this absorption is experimentally evidenced by study of (1) gyro-interaction of microwaves of different frequencies, (2) emission of microwave noise power at frequencies fn greater than fH, (3) intensity of visible light excitation, and (4) rapid disintegration of the plasma. A correlation of these experimental results show that (1) the rate of heating of any specific region of the plasma changes drastically during different time intervals of the pulsed resonant heating microwave signal and (2) non-uniform heating occurs along the plasma axis. Implication of these results on wave propagation in a magnetoplasma is discussed. Electron cyclotron resonance absorption of microwave energy by the electron gas in decaying magnetoplasmas of oxygen and nitrogen gases is investigated. (auth)

37906 (AD-609942) A CONJECTURE ABOUT THE STRUCTURE OF A MAGNETIC SHOCK WAVE IN A PLASMA. Final Report, Part III. Treve, Yvain M. (American Science and Engineering, Inc., Cambridge, Mass.). July 1, 1964. Contract AF19(628)-2388. 41p. (AFCRL-64-594(III); ASE-654) $2.00(CFSTI)

A model is considered for the structure of a plane, steady shock wave propagating in an inviscid plasma across a magnetic field normal to the direction of propagation. The model does not possess a solution for relatively small magnetic fields. Assuming that a continuous solution exists in this case when the effects of viscosity are taken into account, it is shown how the occurrence of a sub-shock can be conjectured when these effects becomes vanishingly small. (auth)

37907 (ARL-65-91) INVESTIGATION OF THE DYNAMICS OF IONIZED MEDIA (PLASMAS). Brittin, Wesley E.; Chappell, Willard R. (Physics, Engineering Chemistry Corp., Boulder, Colo.). Mar. 1965. Contract AF33(615)-1334. 125p. CFSTI.

A theory of transport phenomena in a nearly homogeneous system of interacting electrons and photons is developed. A hierarchy of equations is derived which couples the various particle and photon distribution functions. The hierarchy is truncated in a physically intuitive way so that a closed set of equations is obtained. The truncated set of equations is then solved, in various orders of approximation making use of the Bogoluibov assumption concerning the rates of relaxation of correlations and distributions. There results a set of coupled equations for the particle and photon distributions. Terms in the resulting equations correspond to various physical processes such as shielded electron-electron scattering, bremsstrahlung, and Thomson scattering. In addition there occur some unexpected contributions. (auth)

37908 (D1-82-0388) RELATIVISTIC MOTION AND ENERGY GAIN OF CHARGED PARTICLES IN A STANDING WAVE NEAR CYCLOTRON RESONANCE. Hall, Richard B. (Boeing Scientific Research Labs., Seattle, Wash.). Dec. 1964. 23p.

The relativistic equations of motion of a charged particle in an r-f standing wave and a uniform d-c magnetic field are solved by use of a computer. Curves of energy gain, ratios of transverse to longitudinal energy, and interaction times are found for particles that either are reflected from or pass through the r-f field. Some of the effects of relativistic mass increase are found to be predicted by a simple modification of the time-averaged theory. It is proved that, after its interaction with an r-f field having a space variation only along the d-c magnetic field, the guiding center of the charged particle remains unchanged. (auth)

37909 (D1-82-0395) A LOW DENSITY UNIVERSAL INSTABILITY. Hoh, F. C. (Boeing Scientific Research Labs., Seattle, Wash.). Dec. 1964. 17p.

It is shown that an ion acoustic wave in a low pressure, non-uniform plasma propagating almost perpendicular to the external magnetic field, is made unstable when finite Debye length is introduced. In connection with this problem, the WKB method, extended to complex potential, as well as the meaning of localized dispersion relations are considered in detail. It is pointed out that, while the local-

ized frequency and growth rate depend upon the slope of the profile, the true values depend sensitively on the curvature of the density profile. (auth)

37910 (IPP-2/36) PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON DIFFUSION OF PLASMA ACROSS A MAGNETIC FIELD, FELDAFING/STARNBERGER SEE, GERMANY, JUNE 29–JULY 3, 1964. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Dec. 1964. 232p. (CONF-640621). Dep.(mn).

Twenty-one papers are included; separate abstracts have been prepared for 16. Five papers were previously abstracted in NSA, 18: 44856, 19: 19295, 21540, 33421, and 33422. (W.L.G.)

For abstracts of individual papers see: 37911, 37912, 37913, 37914, 37915, 37916, 37917, 37918, 37919, 37920, 37921, 37922, 37923, 37924, 37925, and 37926.

37911 (IPP-2/36(p.5-28)) STUDY OF DIFFUSION PLASMA (ENERGY ANALYSIS — DIFFUSION COEFFICIENTS). Bernard, M; Briffod, G.; Frank, B.; Weisse, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

A diffusion plasma was produced that possessed two distinct regions: a source region where the ionization of the gas took place; and a diffusion region where the collisions allowed the flow of the plasma. The experimental study of the velocity distribution function showed the existence of two regions: in the source region, the applied electrical field made the distribution function of the velocity sharply anisotropic and maintained a very important population of ionizing electrons; and in the diffusion region the collisions suppressed this anisotropy. The characteristics of this diffusion plasma seem to be specially adapted to the studies of transport coefficients. (auth)

37912 (IPP-2/36(p.29-36)) INCREASE OF PRESSURE IN AN AXIAL MAGNETIC FIELD. Doebele, F.; Wienecke, R.; Witkowski, S. (Institut fuer Plasmaphysik, G.m.b.H, Garching (West Germany)).

In an electric arc of cylindrical symmetry without mass flow in an axial magnetic field, the radial ambipolar diffusion of electrons and ions is reduced, whereas the diffusion of neutral particles remains unaffected. Therefore, the pressure is not constant in the arc, but increased in the regions of higher temperatures. The results of a detailed numerical analysis are given and discussed. Preliminary experimental results are given and compared with theory. (auth)

37913 (IPP-2/36(p.54-62)) MAGNETIC FIELD DIFFUSION IN A PINCHED DISCHARGE. Lees, D. J.; Berg, H.; Reynolds, P.; Ward, B. A. (Culham Lab., United Kingdom Atomic Energy Authority, Abingdon (England)).

The penetration of magnetic field into a cylindrical plasma is usually treated as a diffusion problem in which the characteristic time is given in terms of the plasma radius and conductivity. Experiments on field penetration have been carried out using a stabilized z pinch of 75 cm bore and up to 5.2 m long, at peak currents of up to 800 kA. It is found that the penetration occurs more rapidly than is given by a resistive diffusion mechanism and that the rate of penetration appears to increase with decreasing density and increasing electric field. The phenomenon is discussed in terms of the forms of instability known to be possible in a discharge of this type and comparisons are made between the observed behavior and the predictions of theory. (auth)

37914 (IPP-2/36(p.71-82)) PLASMA CONFINEMENT IN THE C-STELLARATOR. Yoshikawa, S. (Princeton Univ., N. J. Plasma Physics Lab.).

The confinement of the plasma in the C-stellarator was studied for various parameters. The plasma loss seems to be proportional to the ohmic heating current density $j_{||}$ when $j_{||}$ is high. This agrees with the theory of the drift instability, which is caused by both $j_{||}$ and the density gradient perpendicular to the main confining field B. Even when $j_{||}$ is small or in its absence, a rapid plasma loss is still observed. The cause for this loss may be connected with an imperfect toroidal equilibrium due to effects of the finite resistivity and the finite ion Larmor radius ρ_i. The resistive MHD instabilities are not ruled out, but the observed increase in confining time with the application of a radial field favors the idea that imperfect equilibrium is involved. The oscillation is also observed. The frequency is of the order of $(\rho_i^2/a\lambda_\perp)\omega_i$, where ω_i is the ion cyclotron frequency, a is the e-folding length of the density, and $\lambda_\perp$ is the wavelength perpendicular to B. This frequency agrees with the frequency predicted by either universal instabilities including the drift instability or resistive instabilities with the finite Larmor radius effect. (auth)

37915 (IPP-2/36(p.83-7)) BOUNDS ON DIFFUSION BY MICROINSTABILITIES. Fowler, T. K. (Oak Ridge National Lab., Tenn.).

A thermodynamic bound on anomalous diffusion of electrons transverse to $\vec{B}$ is obtained from the non-linear Vlasov equation. Essentially all microinstabilities are included simultaneously without restriction on β. Under ambipolar conditions, as in closed systems, the electron diffusion coefficient obtained, $D_{\perp e}$, is itself an upper bound on the combined ion-electron coefficient if ambipolar fields are included in calculating $D_{\perp e}$. The only assumptions are: (1) adiabatic electron motion, and (2) negligible wave-wave interaction. By (1), $D_{\perp e} \leq \rho_e^2 Q\gamma$ where ρ_e is the average electron gyroradius, Q is the ratio of microinstability field energy density to electron thermal energy density, and γ^{-1} is an appropriate relaxation time. By (2) γ is taken to be $\leq$ the maximum instability growth constant, obtained previously. A bound on Q is obtained from the free energy relative to thermal equilibrium. One of the terms, Q_0, accounts for turbulence in creating the plasma and is not usually known experimentally. Since existing experiments in stellarators and afterglow plasmas satisfy the bound with modest values of $Q_0 \sim 0.1-0.2$, there is no clear experimental contradiction of the assumptions. On the other hand, granting the assumptions, the predicted thermonuclear critical size is reasonable. In the thermonuclear regime, the best bound (currents minimized) is $D_\perp < \rho_e^2 R^{-1} \beta \omega_p^{-1}$ thermonuclear regime where R is the plasma radius and ω_p is the electron plasma frequency. Then a macroscopically stable, closed configuration of about one meter minor diameter, B ~ 50 kg, would provide adequate thermonuclear confinement. (auth)

37916 (IPP-2/36(p.88-100)) FINITE AMPLITUDE INSTABILITY OF A PLASMA COLUMN. Johnson, R. R. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)).

A weakly ionized cylindrical plasma column was investigated in a longitudinal magnetic field larger than the critical field which makes the plasma column unstable to small perturbations. The restriction of small perturbations was removed by superimposing a finite amplitude helix upon the steady state density and potential. The non-linear effect of the superimposed helix on the steady state density and potential was taken into account. The stability of the system was investigated and conditions for marginal stability were found as a function of the amplitude of the superimposed helix. Results of calculations of electric field, wavelength, and frequency as a function of the magnetic field are given for the helical mode for different values of the amplitude parameter. These results were combined with the energy balance theory of the positive column. The calculation of electric field, wavelength, and frequency as a function of the applied magnetic field for fixed neutral gas pressure was made and found to be in qualitative agreement with experimental data. A hysteresis effect was predicted and the paramagnetism of the positive column above a certain gas pressure was verified. (auth)

37917 (IPP-2/36(p.101-17)) ORIGINS AND EFFECTS OF MICROSCOPIC INSTABILITIES IN REFLEX DISCHARGES. Briffod, G.; Gregoire, M. (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires).

The microscopic character of instabilities observed in the cold cathode reflex discharge was made evident by the detailed study of the high frequency noise spectrum (1 to 5000 MHz) and by an experimental set up which showed the

important role of the shape of the velocity distribution in the enhancement of the instabilities. Different methods made possible the evaluation of the plasma perturbations due to the instabilities and especially the modification of the transport phenomena across the magnetic field. (auth)

37918 (IPP-2/36(p.118-23)) STOCHASTIC THEORY OF DIFFUSION IN A PLASMA ACROSS A MAGNETIC FIELD. Tchen, C. M. (National Bureau of Standards, Washington, D. C.).

A stochastic theory was proposed to investigate the diffusion across a constant magnetic field for the cases of collision and collective oscillations. A general formula was obtained, which shows the two cases separately, and the underlying assumptions permitting such a separation were clarified. It was found that the diffusion by collective oscillations was determined by the wave energy, while the collisional diffusion was determined by the thermal energy. (auth)

37919 (IPP-2/36(p.124-30)) SOME REMARKS ON THE UNIVERSAL INSTABILITIES. Hoh, F. C. (California Univ., La Jolla, San Diego).

A classification of the universal instabilities and an explanation of the mechanism which is operative in some of these instabilities was given. Nonlinear effects were mentioned and a quasilinear theory was given using the simple drift approximation. (auth)

37920 (IPP-2/36(p.156-61)) MULTIDIMENSIONAL PLASMA DIFFUSION IN A MAGNETIC FIELD. Whitehouse, D. R. (Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering and Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

The problem of quiescent, multidimensional, partially-ionized plasma diffusion in a magnetic field is treated. The macroscopic plasma equations are used to investigate the general solutions for the density, currents, and electric field in the plasma. (W.L.G.)

37921 (IPP-2/36(p.162-4)) HYDROMAGNETIC TURBULENCE AND DIFFUSION IN ZETA. Robinson, D. C. (Manchester Univ. (England)); Rusbridge, M. G. (Culham Lab., United Kingdom Atomic Energy Authority, Abingdon (England)).

A model for the behavior of large scale electric field fluctuations in the Zeta discharge is discussed. Smaller scale fluctuations contribute to the resistive dissipation and appear as an enhanced resistivity with a small effect. Diffusion in the Zeta discharge is discussed using a model of hydromagnetic turbulence in an infinite homogeneous electrically conducting fluid immersed in a uniform magnetic field, and subject to random external nonelectromagnetic forces. (W.L.G.)

37922 (IPP-2/36(p.165-82)) ON THE TURBULENCE OF THE POSITIVE COLUMN IN A LARGE LONGITUDINAL MAGNETIC FIELD. Woehler, K. H. (Naval Postgraduate School, Monterey, Calif.).

The positive column of a cylindrical low pressure discharge in rare gases at pressures between 0.01 and several torr is known to become unstable if the longitudinal magnetic field exceeds a certain critical value. At magnetic fields very much larger than the critical field the motion of the charged particles, particularly the electrons, eventually take on a turbulent character due to excitation of higher modes of the helical instability. B. Kadomtsev developed a theory of this turbulent motion on the basis of the mixing length theory of turbulence and predicted the order of magnitude of the characteristic mixing length and the electron density profile of the turbulent column. In a He discharge of 0.15 torr at a magnetic field of 5000 gauss the characteristic length of the turbulent motion was determined by measuring the correlation of the signals from two probes as a function of the probe distance. The density profile of the turbulent column was measured and compared with the prediction. It was found that the turbulence length is strongly dependent on the direction with respect to the magnetic field. It was rather undefined along the direction of the field. It was almost an order of magnitude larger as predicted perpendicular to the field. It was found that the pressure dependence of the characteristic length was in contradiction to the prediction, also the density profile did not agree with the prediction. (auth)

37923 (IPP-2/36(p.183-5)) THEORETICAL STUDY OF ANOMALOUS DIFFUSION AND TURBULENCE IN THE POSITIVE COLUMN. Hoh, F. C. (California Univ., La Jolla, San Diego).

An outline is given of further experimental and theoretical work which may be done on the positive column in a magnetic field. (auth)

37924 (IPP-2/36(p.186-7)) SECULAR STABILITY OF THE POSITIVE COLUMN. Hoh, F. C. (California Univ., La Jolla, San Diego).

A model is proposed to explain the existence of a second critical magnetic field observed during an experiment in which a positive column was inserted in a microwave guide and the absorption of the microwave signal observed. At a magnetic field several hundred gauss above the field corresponding to the screw instability, the observed frequency suddenly doubled its value. The second critical field exhibited hysteresis. (W.L.G.)

37925 (IPP-2/36(p.188-219)) STUDY OF INSTABILITIES AND TRANSITION TO TURBULENT CONDUCTION IN THE PRESENCE OF HALL CURRENTS. Hess, R. V.; Burlock, J.; Sidney, B; Brockman, P.; Brooks, D. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center).

Results of a study made of the transition from normal to turbulent behavior of the plasma in a linear Hall accelerator are presented. (auth)

37926 (IPP-2/36(p.220-31)) MEASUREMENTS ON PLASMA VORTICES AND TURBULENCE. Bostick, W. H.; Farber, E.; Prior, W.; Byfield, H.; DiMarco, J.; Wells, D. (Stevens Inst. of Tech., Hoboken, N. J.).

The situations where plasma vortices were observed and studied are discussed. These situations are: in the flow of Cu and Li plasma over a magnetic dipole; in the coaxial plasma accelerator with H_2, N_2, and Ar; and in firing a plasma gun across a magnetic field. In all of these situations the plasma is in an accelerated frame of reference and Rayleigh-Taylor instabilities are expected to produce flutes. (W.L.G.)

37927 (MATT-268) POWER BALANCE IN HELIUM DISCHARGES IN THE C STELLARATOR. Bishop, A. S.; Gibson, A.; Hinnov, E.; Hofmann, F. W. (Princeton Univ., N. J. Plasma Physics Lab.). May 1964. Contract AT (30-1)-1238. 51p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Power balance measurements have been carried out for helium discharges in the C-Stellarator over a wide range of ohmic heating currents. The results show that the power input can be satisfactorily accounted for in terms of power dissipated in radiation, ionization, and heating of the helium. Power loss due to impurity radiation is negligible; that due to charge exchange is shown to be insignificant (except possibly at very low currents). Other mechanisms of power loss appear to play no major role in the power balance analysis. (auth)

37928 (MATT-333) EXPERIMENTS WITH CESIUM PLASMAS IN A MAGNETIC FIELD WITH VARIABLE CURVATURE. D'Angelo, N.; Goeler, S. v. (Princeton Univ., N. J. Plasma Physics Lab.). June 1965. Contract AT(30-1)-1238. 50p. (CONF-650806-2) Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

From 7th International Conference on Phenomena in Ionized Gases, Belgrade.

Experiments were performed with a thermally ionized cesium plasma in a magnetic field with variable curvature. As the radius of curvature of the magnetic lines, R, is decreased from its normal value $R = \infty$, excitation of several modes of low-frequency (5–30 kc) drift waves and the appearance of additional plasma losses are observed. Lack of toroidal equilibrium was analyzed theoretically and experimentally. The connection between the low-frequency drift waves and the additional losses is discussed. (auth)

37929 (MPI-PA-29/64) PARTICLE LOSSES OF A CESIUM PLASMA IN A STELLARATOR. [PART] 2. Eckhartt, D.; Grieger, G. (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). Oct. 1964. 20p. Dep.(mn).

The behavior of a quiescent thermal Cs plasma in a stellarator magnetic field is studied. The plasma is formed by contact ionization on a hot metal surface whose temperature is equal to T_i and to T_e. The mechanism which brings the plasma into equilibrium with the magnetic field forces is analyzed, taking the finite plasma resistivity into account. A scaling law, enabling results from the alkali plasma to be compared with those for a H plasma, is derived. Experiments on H_2 and Cs in the stellarator Wendelstein are discussed, and a tentative explanation of the observed plasma behavior is given. Further experiments are proposed for verifying this explanation. (M.J.T.)

37930 (N64-22477) RADIATION FIELD OF AN ARBITRARY ANTENNA IN A MAGNETOPLASMA. Deschamps, Georges A.; Kesler, O (Illinois Univ., Urbana. Antenna Lab.). May 1, 1964. 12p. (NASA-CR-56291).

The problem of finding the far field of an antenna in a magnetoplasma such as the ionsphere was previously solved. The result is rederived in a simpler manner and expressed in terms of the normalized characteristic plane waves of the medium. This has the advantage of showing clearly how the far field depends on the free space pattern of the antenna, on the shape of the dispersion surface, and on the polarization of the characteristic waves. In the derivation use is made of the magnetic field instead of the electric field. Because the polarization of this vector is easier to express, both the deduction of the result and its application to actual pattern computations are simplified. (M.O.W.)

37931 (N64-27248) ON THE STRUCTURE OF A COLLISION FREE WAVE IN A PLASMA TRANSVERSE TO A MAGNETIC FIELD. Jaggi, R. K.; Stokes, A. P. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb. 1964. 26p. (NASA-TM-X-55010). CFSTI, $2.60 cy.

The problem of the structure of a strong collision free wave in a plasma perpendicular to its magnetic field is considered. Conditions on the two sides of the wave are the same and are separated by a solitary pulse, provided the kinetic energy of the motion at one end of the wave ($x = -\infty$, say) is less than the sum of magnetic and thermal energy of the plasma. If the kinetic energy is more than the sum of magnetic and thermal energy, no wave exists, and the constant solution at $x = -\infty$ is the only solution of the equations describing the waveform. (auth)

37932 (N64-29689) PULSED ELECTROMAGNETIC GAS ACCELERATION. Fourth Semi-Annual Progress Report, January 1, 1964 to June 30, 1964. Report No. 634c. Jahn, Robert G. (Princeton Univ., N. J. Guggenheim Labs. for the Aerospace Propulsion Sciences). July 31, 1964. 46p. (NASA-CR-58567). CFSTI, $4.60 cy.

Experimental study of the initiation and development of the current pulses in large-radius pinch discharges was facilitated by the construction of a 5-inch, tubular, pinch-generating device. This machine is capable of producing essentially impermeable, cylindrical current sheets that are coupled to the external circuit over most of their inward excursion. Streak and Kerr-cell photography, photoelectric spectroscopy, and magnetic and electric probes revealed many of the interior details of these current pulses, and an auxiliary electrode containing a central orifice leading to a glass vacuum chamber permitted optical observation of the exhaust plume. A lumped-line type of pulse-forming circuit was developed to drive another discharge chamber. This device permits the application of current and voltage waveforms of prescribed profiles to the pinch discharges. (auth)

37933 (N64-33564) STABILITY OF HARD-CORE PINCH WITH ANISOTROPIC PLASMA PRESSURE. Telwar, S. P. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center); Tandon, J. N. (Delhi Univ. (India)). Aug. 1964. (NASA-TM-X-55091). CFSTI, $2.00 cy, $0.50 mn.

A hard-core pinch device is described consisting of an annular plasma detached from the central core and from the surrounding conducting wall by opposite axial currents flowing in the core and the plasma. The instability of the configuration is investigated, with the emphasis on the plasma pressure being anisotropic rather than scalar. This condition occurs in a dilute plasma subjected to a high magnetic field. The usual normal-mode technique is applied, and a dispersion formula is obtained with the double-adiabatic hydromagnetic equations and is discussed for marginal stability for axisymmetric perturbations. (auth)

37934 (N64-33632) THE INTENSIFICATION OF MAGNETIC FIELDS IN PLASMAS. Jaggi, R. K. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). July 1964. 28p. (NASA-TM-X-55076). CFSTI, $1.00 cy.

Magnetohydrodynamic equations are used to obtain the solution to the problem of intensification of the magnetic field in an infinite plasma containing a uniform magnetic field by a motion of the semi-infinite plasma perpendicular to the field. Self-consistent solution of the problem shows that a finite amount of magnetic field is produced in the direction of motion of the plasma. When the velocity of the medium is independent of time, the magnetic field produced in the direction of motion is proportional to $\sqrt{t}$, and any amount of magnetic field can be produced. (auth)

37935 (N64-33635) NON-LINEAR CONSTANT-PROFILE WAVES IN A COLD PLASMA UNDER AN APPLIED MAGNETIC FIELD. Alloucherie, Yves J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). July 1964. 40p. (NASA-TM-X-55083). CFSTI, $2.00 cy.

Nonlinear coupled differential equations for the two transverse components of the local magnetic field were obtained for a plane wave propagating in a homogeneous cold Vlasov plasma under the influence of an external magnetic field B_0, for any angle $(90° - \alpha)$ between B_0 and the wave vector. There is one exact single valued solution and approximate multiple valued solutions for $\alpha = 90°$; for $\alpha = 0°$, the solution is reducible to an integral and is multiple valued. A perturbation method was used to obtain a restricted class of solutions for intermediate angles. A numerical example was worked out in detail for a specific value of the field energy density and for 12 different angles; the plasma parameters in this example are those appropriate to the ionosphere of the earth. (auth)

37936 (NP-15135) STUDY OF COLLISION PROCESSES IN GASEOUS PLASMAS. Semi-annual Technical Report No. 3. Oskam, H. J. (ed.) (Minnesota Univ., Minneapolis. Plasma Physics Lab.). Mar. 1965. Contract Nonr-710(37). 18p.

Studies related to collision processes in gaseous plasmas are summarized. A detailed description of the SLEAMA II measuring system is presented. Results obtained with the SLEAMA I system are summarized, while a necessary redesign of the auxiliary electronics for the ion mobility measuring tube is described. (M.O.W.)

37937 (ORNL-P-1429) THE OAK RIDGE MULTIPLE-PASS INJECTION EXPERIMENT, DCX-2. Bell, P. R.; Gibbons, R. A.; Kelley, G. G.; Lazar, N. H.; Lyon, J. F.; Stratton, R. F. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 20p. (CONF-650911-1). Dep. (mn); $1.00(cy), 1(mn) CFSTI.

For Presentation at 2nd Conference on Plasma Physics and Controlled Nuclear Fusion Research, Abingdon, Berks, England.

Results of the experiments with DCX-2 are presented. The experiments are divided into two classes: (1) Dissociation of the molecular ion beam by the background gas and secondary plasma. Roughly 40% of the protons produced are in orbits which will not strike the injector when the

orbit precesses about the axis of the machine. (2) Enhanced dissociation of the molecular ion beam in a dense high vacuum arc. The arc is situated along flux lines which pass through the molecular ion helix diametrically opposite the injection point. All protons formed in the arc must be scattered radially more than one Larmor radius to strike the injector. Both lithium and hydrogen arcs were used for this purpose. (M.O.W.)

37938 (ORNL-TM-1126) INVESTIGATION OF PLASMA RADIATION FROM ELECTRON BOMBARDED ALUMINUM FOILS AS A FUNCTION OF THE ANGLE OF OBSERVATION AND THE FOIL THICKNESS. Hanson, W. F.; Herickhoff, R. J.; Arakawa, E. T.; Birkhoff, R. D. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 65p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Thesis submitted to Vanderbilt Univ., Nashville, Tenn.

The angular distribution of photons emitted from aluminum foils 320 Å in thickness bombarded with 80 kev electrons, and the dependence of the peak intensity on foil thickness were determined experimentally in the wavelength region from 700 to 1100 Å. The absolute efficiency of the optical spectrometer was determined in the visible wavelength region from a standard lamp and extrapolated into the vacuum ultraviolet wavelength region using the measured grating efficiency and the quantum efficiency of sodium salicylate. Experimental photon intensities were found to be approximately 40% lower than the photon intensities predicted by the transition radiation theory. The intensity of the emission at the peak wavelength exhibited maxima at 22 and 157° from the foil normal; the intensity dropped to zero at 0, 180, and 90°. The angles for which the theoretical curves exhibit maximum intensity are 15° and 168°. The wavelength for which the experimental spectra exhibit maximum intensity was found to decrease as the angle of observation increased from 0° or decreased from 180°. A plot of the wavelength of maximum emission versus the angle of observation was extrapolated to 0° to obtain the plasma wavelength, 835 Å. The intensity of the wavelength of maximum emission was found to decrease rapidly as the foil thickness was increased from 180 to 400 Å and then to remain fairly constant out to 700 Å. The experimental results are in good agreement with transition radiation theory. (auth)

37939 (SC-R-64-1361) PROPAGATION OF AN ELECTROMAGNETIC WAVE IN A TIME-VARYING MEDIUM. PART I. GENERAL THEORY. Kunz, Kaiser S. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1964. Contract AT(29-1)789. 24p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Sandia Corp. Monograph.

A firm mathematical basis for the treatment of electromagnetic waves in time-varying media is established. The medium is assumed conductive, nonhomogeneous, and time-varying, but is isotropic with linear relations between $\vec{D}$ and $\vec{E}$, $\vec{B}$ and $\vec{H}$, and $\vec{J}$ and $\vec{E}$, which define the macroscopic properties ϵ, μ, and σ of the medium. Wave equations for the field vectors are derived. The wave equation is solved for a homogeneous medium with time-varying parameters ϵ, μ, and σ, and it is shown how the solution may be made to satisfy simple boundary conditions. (M.J.T.)

37940 (TID-21845) THE STUDY OF PLASMA DIFFUSION ACROSS MAGNETIC FIELDS. Quarterly Status Report No. 12, February 1, 1965–April 30, 1965. Buneman, O. (Stanford Univ., Calif. Inst. for Plasma Research). May 1965. Contract AT(04-3)-326. 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress on three projects is reported. (1) Studies were made on diffusion in a cylindrical discharge in a strong axial magnetic field. Theoretical and experimental investigations were carried out on the effects of discharge instabilities on the diffusion rates in order to explain the discrepancy between measured diffusion rates across the field and those predicted by the binary collision theory. Density decay in the afterglow of a toroidal reflex discharge in the Bagel machine was studied; the measured and theoretically predicted diffusion coefficients are considerably different. (2) The growth of plasma fluctuations in a plasma subjected to an external electric field was investigated theoretically, according to the linearized equations. Discussions are given of the basic equations, limitations of the model, the nature of the solution valid in the full time range, and the velocity distribution functions leading to the polynomial dispersion relations. (3) A theoretical study of instabilities in a plasma current sheet is summarized. (M.J.T.)

37941 (TID-21943) DAMPING AT THE LOWER HYBRID RESONANCE IN A WARM PARTIALLY IONIZED PLASMA. Technical Report. Oakes, M. E.; Schlueter, H. (Texas Univ., Austin. Plasma Physics Lab.). Feb. 1965. Contract AT(40-1)-3110. 23p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

It is shown from a three-fluid analysis including electron pressure that the strong neutral component present in a previous experimental study of the hybrid ion-electron resonance simply increases the damping and, for the range of parameters involved, suppresses the effects of pressure terms on the resonance features. (auth)

37942 (TID-22045) PROGRESS REPORT [ON PLASMA RESEARCH], APRIL 1, 1965-JUNE 30, 1965. Hoyaux, M. F.; Penney, G. W.; Young, F. J.; Glaude, V. M. M.; Linton, G. D.; Kettani, A.; Williams, E. M. (Carnegie Inst. of Tech., Pittsburgh, Pa.). Contract AT(30-1)-3100. 10p. (EAC-6) Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

Experimental work was concerned with (a) tests of double-probe instrumentation and (b) some attempts to determine the region of the double sheath or plasma sac in which the randomization phenomenon is concentrated and the relaxation length associated therewith. Theoretical work was concerned with hypotheses for the randomization process. Two hypotheses have emerged (1) that this process occurs predominantly in the double sheath, as a result of an electron drift velocity approaching or exceeding the velocity of electrostatic-acoustic waves or (2) that the process occurs at the entrance to the plasma sac, as a result of beam-plasma interaction supported microwave oscillations in the relatively low-density cavity formed by the sac and double sheath. (auth)

37943 (UCRL-12434) OBSERVATION OF A VELOCITY-DISTRIBUTION INSTABILITY. Perkins, W. A.; Barr, W. L. (Lawrence Radiation Lab., Univ. of California, Livermore). June 22, 1965. Contract W-7405-eng-48. 28p. (CONF-650911-6). Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

For Presentation at 2nd Conference on Plasma Physics and Controlled Nuclear Fusion Research, Abingdon, Berks, England.

Experiments were performed with plasma contained in the magnetic field configuration formed by superimposing quadrupole windings on a magnetic mirror field to determine; if a hot electron plasma would be stabilized against the flute instability, and if any other macroscopic or microscopic instabilities would occur in such a field configuration. A new instability is observed and appears to be a microinstability, caused by a nonmaxwellian velocity distribution. This instability is examined. (M.O.W.)

37944 (UCRL-14120) ABSTRACTS [OF PAPERS FROM] SYMPOSIUM ON ENGINEERING PROBLEMS OF CONTROLLED THERMONUCLEAR RESEARCH, MAY 4-7, 1965. (Lawrence Radiation Lab., Univ. of California, Livermore). Contract W-7405-eng-48. 50p. (CONF-650512). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Abstracts of 53 papers are included. (T.F.H.)

37945 (UCRL-14243) STABILITY OF A MAGNETICALLY CONFINED 20-kev STEADY-STATE PLASMA. Futch, A. H. Jr.; Damm, C. C.; Foote, J. H.; Freis, R.; Gordon, F. J.; Hunt, A. L.; Killeen, J.; Moses, K. G.; Post, R. F.; Steinhaus, J. F. (Lawrence Radiation Lab., Univ. of California, Livermore). June 23, 1965. Contract W-7405-eng-48. 26p. (CONF-650911-5). Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

For Presentation at 2nd Conference on Plasma Physics and Controlled Nuclear Fusion Research, Abingdon, Berks, England.

The neutral-injection method of plasma formation permits the generation of high kinetic temperature plasmas in various confining magnetic fields. This method was used to form 20-kev hydrogen plasmas in order to study their stability in a simple magnetic mirror field and in composite fields produced by adding multipole line cusps to the mirror field. Observations of low-frequency oscillations and of a limitation on trapped ion-density are interpreted in terms of a low-frequency drift instability. A theoretical treatment of this instability which includes some effects not previously calculated with numerical solutions of the resulting differential equations is presented. Plasmas formed in composite fields having a region of nonzero field minimum are described. Results on the suppression of ion losses due to drift instability which were reported earlier were extended. Additional observations relating to the remaining ion losses are described. (M.O.W.)

37946 (UTIAS-108) THE DETERMINATION OF SPATIALLY NON-UNIFORM ELECTRON DENSITY DISTRIBUTION. Graf, Kurt A. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Apr. 1965. 112p. (AFOSR-65-0935)

Electron densities were measured in the subsonic portion of a free-expansion argon jet by microwave and Langmuir probe methods. The electron density in the jet had a Gaussian radial distribution; along the axis of the jet the density fell off approximately exponentially. Microwave measurements were made by traversing the microwave beam across the jet. This allowed the spatial variation of electron density to be determined. The data were analyzed with a ray-tracing technique. Langmuir probe measurements were made with cylindrical and flat probes under essentially collision free conditions and over a range of probe radius to Debye length ratios of about 10 to 50. Both electron and ion collection were measured and analyzed. The electron-current part of the characteristic has, in the past, been interpreted in two different ways. These are the so-called "deviation-from-linearity" method, and the "two-tangent-intercept" method. For a probe in free-molecular flow, electron densities determined by these methods (for the type of plasma under consideration and ideal probe characteristics) should not differ by more than about 30%. It was found, however, that the latter method gave values two or three times higher than the former method. This difficulty was overcome by analyzing the data with the aid of theoretical particle-collection curves. The ratio of ion and electron temperatures, and the ratio of probe radius to Debye length were taken into account. Using this procedure, the probe data agreed very well with the microwave data. (auth)

37947 (NASA-TT-F-169) INVESTIGATION OF THE ESCAPE OF CHARGED PARTICLES FROM A PLASMA IN A MAGNETIC FIELD. Pasichnyk, L. L.; Kozak, O. V. Translated from Ukr. Fiz. Zh., 7: 1165-70(1962). 11p. CFSTI, $1.00 cy.

The emergence of charges from a hot-cathode plasma under low pressure in a magnetic field was studied for H_2 and other gases. The spectrum of high-frequency oscillations generated by the discharge was also studied. Probe current-magnetic field plots show minima for critical values of the magnetic field. The critical magnetic field depends strongly on the gas pressure. It was shown that the oscillations are directly connected with the expansion of the plasma column, probably through the cathode-adjacent layer. (D.L.C.)

37948 DISPERSION RELATION FOR A LONGITUDINAL PLASMA WAVE IN THE PRESENCE OF A MAGNETIC FIELD. Arbab, Farzam (Amherst Coll., Mass.); Rosen, Philip. Am. J. Phys., 33: 556-62(July 1965).

A dispersion relation for electron longitudinal waves in a plasma which has an arbitrary magnetic field along the z axis is derived. The electron velocity distribution function is allowed to be quite general. (auth)

37949 RADIO FREQUENCY PLASMAS AT THE HYBRID ION-ELECTRON RESONANCE. Schlueter, H.; Ransom, C. J. (Univ. of Texas, Austin). Ann. Phys. (N. Y.); 33: 360-380(July 1965).

For wave propagation perpendicular to the static magnetic field of plasmas a resonance is to be expected at the geometrical mean of the ion and electron cyclotron frequency if the plasma frequency is large compared to the electron cyclotron frequency. At this resonance, the so called hybrid ion-electron resonance, the resistive impedance for an external power source has a minimum. Corresponding extrema in the loading of a steady state 10 kw oscillator are observed, virtually at the geometrical mean frequency. The observations are made in hydrogen, deuterium, and helium radio frequency plasmas for different oscillator frequencies from 13 to 30 Mc and gas pressures from 5.10^{-3} to 6.10^{-2} mm Hg. The density condition for the occurrence of the hybrid resonance is fulfilled as spectroscopic, microwave, and probe density measurements show. (auth)

37950 HIGH-VOLTAGE BREAKDOWN INITIATED BY PARTICLE IMPACT. Slattery, J. C.; Fritchtenicht, J. F.; Hansen, D. O. (TRW Space Tech. Labs., Redondo Beach, Calif.). Appl. Phys. Letters, 7: 23-5(July 1, 1965).

Experiments are summarized by which the particle-initiated high-voltage breakdown hypothesis of Cranberg was studied by injecting accelerated iron ions through an aperture in one electrode of a plane parallel electrode configuration. The existence of a low-energy limit for particles capable of initiating discharge was verified and measured. A definite polarity dependence was noted, and the effects of applied voltage and electric field were observed qualitatively. (D.C.W.)

37951 MAGNETOHYDRODYNAMIC FLOW AND FORCE-FREE FIELDS. Menzel, Donald H. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. Norvegica, 9: 225-32(1964).

The MHD equations of motion of a compressible medium are obtained for steady-state conditions, motion-balanced systems, force-free fields, and current-balanced fields, in terms of velocity, density, gas pressure, potential function of external forces, magnetic field, and permeability. (M.J.T.)

37952 SOME REMARKS ON THE EQUATION OF STATE OF FULLY IONIZED GASES. Haar, D. Ter (Oxford Univ.); Wergeland, Harald. Astrophys. Norvegica, 9: 233-8(1964).

A general summary is given of the Debye-Hueckel theory for the statistical mechanics of ionized systems. The Debye-Hueckel expression for the average Coulomb energy in terms of the Debye radius and derivations of the Coulomb correction to the pressure are discussed. The invariance of the ratio V/r_D^3 at constant entropy is shown. (M.J.T.)

37953 TWO-STREAM INSTABILITIES IN A PLASMA. Kundu, S. K. (Australian National Univ., Canberra). Australian J. Phys., 18: 271-6(June 1965).

A phenomenological scattering formula is used to investigate the effect of collision on the two-stream instabilities in a plasma of interstreaming electrons and ions. The result is that the enhanced Landau damping due to thermalized electron energy competes with the growth of the instability. (auth)

37954 THE QUEST FOR CONTROLLED THERMONUCLEAR POWER. Ware, A. A. Electron. Power, 11: 12-16(Jan. 1965).

A review is presented of methods of research armed at producing useful power from thermonuclear reactions. The methods of approach and associated problems are discussed, and are tabulated according to the degree of curvature and shear of their magnetic fields. (L.E.S.)

37955 STARTING OF A 1.5-MWs-IMPULSE-CURRENT GENERATOR AT THE INSTITUTE FOR PLASMA-PHYSICS AT GARCHING. Knobloch, A.; Ulrich, M. Elektrotech. Z., 17: 136(Mar. 12, 1965). (In German)

A 1.5-MWs pulsed current generator for 30-kv charge voltage to be used as the energy source for a large theta-

pinch experiment was put into operation. The design and characteristics of the generator are briefly described. (J.S.R.)

37956 THE MECHANISM OF THE STRATIFICATION IN GAS DISCHARGE. Chapnik, I. M. (Novosibirsk Electrotechnical Inst., USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 2, Ser. Tekhn. Nauk, No. 1, 81-90(1965). (In Russian)

The theory of laminated gas cylinders was studied as a generalized theory of the homogeneous Schottky cylinder. It is assumed that the striated discharge is represented by temperature waves in an electron-ion plasma which have a finite length (up to several tube diameters) at frequency equal to zero. Processes of the ambipolar thermodiffusion of charged particles along the cylinder axis, the ambipolar diffusion in the tube walls, and the ionization of gas atoms by electron shocks play an important part in the appearance of the stratification. The appearance of a uniform cylinder, stationary lamination, or moving layers depends on the boundary conditions at the end of the cylinder (moving layers appear in oscillating boundary conditions). It is suggested that the lamination of the cylinder is based on a certain idealization of incompressible plasma. Such simplification explains the continuous stationary layers and moving layers whose length does not depend on the frequency. It is quite possible that such conditions may exist in some mixed gases. It is suggested that the process of ambipolar thermodiffusion should be taken into account in the theory of gas discharge cathode parts and in plasma investigations. However, there is no satisfactory theory of stationary incompressible plasma which is capable of explaining the changes along the charged particle concentration cylinder or the attenuation of layers and changes of their dimensions with increasing frequency. (R.V.J.)

37957 DISCHARGE IN A LARGE-SIZE HOLLOW CATHODE. Klement'ev, V. M. (Inst. of Radiophysics and Electronics, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 2, Ser. Tekhn. Nauk, No. 1, 91-5 (1965). (In Russian)

The feasibility of producing a homogeneous plasma with electron density $n_e > 10^{13}$ cm^{-3} in a large radius cylindrical hollow cathode was investigated in order to determine the cathode reflectance at eight millimeter wave range. (R.V.J.)

37958 INSTANTANEOUS DIRECT-DISPLAY SYSTEM OF PLASMA PARAMETERS BY MEANS OF TRIPLE PROBE. Chen, Sin-li; Sekiguchi, T. (Tokyo Univ.). J. Appl. Phys., 36: 2363-75(Aug. 1965).

An electrostatic probe method utilizing the triple probe is proposed in which no voltage or frequency sweep (or switching) is required. This feature permits determination of the instantaneous values of the electron temperature (T_e), as well as the electron density (n_e), within a short time which is of the order of the intrinsic response time of the probe itself (≈1 μsec). Moreover, the system allows the direct display of the T_e values, as well as the semi-direct display of the n_e values on appropriate display units, thus permitting elimination of almost all procedures usually required for data processing. In view of the features mentioned, this system may be a useful diagnostic tool not only for stationary plasmas but also for rapidly varying time-dependent plasmas of various types. Theoretical considerations for the instantaneous direct-display system using a symmetrical triple probe are presented. Discussions are also presented for the estimation of errors caused by the variation of ion saturation current, for the application to magnetoplasmas, and for the time and spatial resolutions. Experimental confirmation was made through the measurements of stationary magneto- as well as non-magneto-plasmas. As an example of the application to time-dependent plasmas, the electron temperature waves accompanied by the moving striations in hydrogen discharge were observed. (auth)

37959 HARMONIC GENERATION AND PARAMETRIC OSCILLATIONS IN A PLASMA. Krenz, J. H.; Kino, G. S. (Stanford Univ., Calif). J. Appl. Phys., 36: 2387-95(Aug. 1965).

Nonlinear r-f effects in plasmas are discussed. It is shown that the strong type of harmonic generation mechanism is due to the equation of motion for the plasma electrons being nonlinear, as is the relation between current and velocity. A theory of plasma harmonic generators and parametric oscillators is given. Input reaction is taken into account, and it is shown that a resonance at the output frequency tends to lead to high efficiency. Such a resonance is the electrostatic resonance of a plasma sphere. Experiments carried out with a small spherical r-f discharge are described. A 25% conversion efficiency to the second harmonic of an S-band signal was obtained. Measurements were made up to the seventh harmonic. For maximum efficiency a plasma resonance at the harmonic of interest is required. By tuning the system to be resonant at half the input frequency, parametric oscillations were obtained at this frequency, thus proving that the nonlinearity must be of a reactive type. It is believed this is the first time that parametric oscillations have been observed in a plasma. (auth)

37960 PLASMA MICROWAVE INTERACTION. Kerzar, B.; Weissglas, P. (Uppsala Univ.). J. Appl. Phys., 36: 2479-84(Aug. 1965).

Transmission characteristics of a rectangular waveguide with a perpendicularly inserted mercury-vapor discharge tube, were measured. The waveguide was excited in the TE_{01} mode, and the plasma column was either perpendicular or parallel to the electric vector of the waveguide mode. In the first case, the transmission spectrum contains the well-known Tonks-Dattner resonances and some additional unexplained small peaks. In the second case, the transmission spectrum has only small peaks superimposed on a smooth curve. Noise emission spectra were also measured for both polarizations and showed the same characteristics as the absorption spectrum. To explain these results, dispersion curves were measured for the symmetric, dipole, and quadrupole modes propagating on the plasma cylinder. In addition the dispersion curve for a new symmetric mode was measured. This mode is of the same nature as the fast dipole modes responsible for the subsidiary Tonks-Dattner resonances. By combining these experimental results it has proved possible to gain an understanding of how the various peaks in the transmission spectrum are caused by coupling to plasma waves. In particular, the small previously unexplained peaks are due to coupling to slow plasma waves as also has been proved by direct measurement of the slow waves leaking out through the holes in the waveguides. (auth)

37961 TIME-DEPENDENT COMPUTER ANALYSIS OF ELECTRON-WAVE INTERACTION IN CROSSED FIELDS. Yu, S. P. (Litton Industries, San Carlos, Calif.); Kooyers, G. P.; Buneman, O. J. Appl. Phys., 36: 2550-9(Aug. 1965).

A time-dependent analysis of crossed-field interaction was formulated for computer calculation. The computer program has achieved, for the first time, accurate and complete simulation of the magnetron oscillator, magnetron amplifier, and smooth-bore magnetron. The computer results are reliable enough to serve as design information. They also indicate that the nature of the interaction is turbulent in the sense that the operation of these devices borders between order and disorder under certain conditions. The techniques used in this analysis are applicable to a wide range of problems dealing with other types of electron-wave interaction, and to plasmas. (auth)

37962 FAR INFRA-RED FARADAY ROTATION IN PLASMA. Dellis, A. N.; Earl, W. H. F.; Malein, A.; Ward, S. (United Kingdom Atomic Energy Authority, Abingdon, Berks, Eng.). Nature, 206: 56-9(July 3, 1965).

Faraday rotations in a plasma of several degrees per kilogauss are reported. They were observed using a pulsed water vapor laser as a source. Oscillograms are shown. Faraday rotation at $\lambda = 27.9$ μ was clearly demonstrated. (M.C.G.)

37963 SPECTRUM OF LASER LIGHT SCATTERED FROM A SINGLE GIANT PULSE IN A LABORATORY PLASMA. Bartoli, U. Ascoli; Katzenstein, J.; Lovisetto, L. (EURATOM-CNEN, Frascati, Rome). Nature, 206: 63-4(July 3, 1965).

The forward scattering spectrum of a laser beam in a θ-pinch plasma was studied using a 14-channel photoelectric spectrum analyzer constructed using the Fabry–Perot etalon as the dispersing element. The ion temperature computed from the profile was ~ 50 ev. The spectrum showed evidence of the weak maxima predicted by the theory. A slight asymmetry toward shorter wavelengths was observed. (M.C.G.)

37964 MAXIMUM GROWTH RATE OF RAYLEIGH-TAYLOR INSTABILITIES DUE TO AN ELECTROMAGNETIC FORCE. Baker, R. C. (Cambridge Univ., Eng.). Nature, 206: 65-6(July 3, 1965).

Rayleigh–Taylor instabilities such as might affect the flow of a striated fluid in a magnetohydrodymamic generator duct were investigated. A trough about 1 × 1 × 2 in. deep was set in a magnetic field and partly filled with mercury. Current could be passed through the mercury at right angles to both the field and the vertical. Tests were run to obtain the maximum growth rate of instabilities. At just unstable conditions the mercury rose in a two-dimensional wave with the crest running from one electrode to the other. (M.C.G.)

37965 THE INTERACTION OF RADIATION WITH CHARGED PARTICLES. [PART] I. Chappell, W. R. (Univ. of Colorado, Boulder); Brittin, W. E.; Glass, S. J. Nuovo Cimento (10), 38: 1186-91(Aug. 1, 1965).

The Bogoliubov-Tyablikov transformation and an equation of motion method, utilizing part of the hamiltonian for a system of interacting electrons and photons, are employed to obtain the familiar dispersion relation, $\omega^2 = k^2c^2 + \omega_p^2$, for a system of quasiphotons. The equation of motion method can be used to obtain an extended dispersion relation when more terms of the hamiltonian are taken into account. (auth)

37966 INCOHERENT SCATTERING OF LIGHT FROM ANISOTROPIC DEGENERATE PLASMAS. Platzman, P. M. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 139: A379-87(July 19, 1965).

The differential scattering cross section for monochromatic radiation incident on an anisotropic degenerate plasma is calculated. The charge carriers are assumed to have ellipsoidal energy surfaces such that relatively undamped plasma acoustic modes exist. The line shape of the scattered radiation depends strongly on the existence of degeneracy and on the nature of the anisotropy. The scattering for small values of energy (ω) and momentum (q) transferred to the plasma is dominated by the excitation of plasma acoustic modes. The spectrum of the scattered radiation exhibits a dip for values of $\omega/q = V_F$. Numerical calculations of the differential scattering cross section for a typical set of parameters are presented. The effects of an externally imposed electron drift are included. (auth)

37967 NEW APPROACH TO THE THEORY OF FLUCTUATIONS IN A PLASMA. Weinstock, Jerome (National Bureau of Standards, Washington, D. C.). Phys. Rev., 139: A388-93(July 19, 1965).

A rigorous but simple method is presented for calculating autocorrelation functions (fluctuations) of nonequilibrium plasmas–including inhomogeneous and nonstationary plasmas–in external fields. This method is based upon the derivation of an exact and remarkably simple formal relation between autocorrelation functions and the usual one-particle distribution function $f_1(R,v,t)$ for an explicitly defined initial value. This relation explicitly reduces the problem of calculating fluctuation spectra to the problem of solving the usual kinetic equations for $f_1(R,v,t)$. Consequently, the central quantity of fluctuation theory is one and the same with the central quantity of kinetic theory, and the two theories are completely and explicitly united. To first order in the plasma parameter it is shown that one need only solve the linearized Vlasov equation for $f_1(R,v,t)$, and when this solution is substituted into the formal relation a general formula for autocorrelation functions which is valid for nonstationary systems and includes the effects of the transverse motion of the plasma in addition to the longitudinal motion is obtained. For stationary systems this formula approaches the numerous calculations of previous authors in the limits where the transverse terms vanish. As a result of the transverse terms, the spectrum of scattered light can have resonant peaks at frequencies which correspond to transverse modes of oscillation as well as to the well-known longitudinal modes. (auth)

37968 ELECTROSTATIC RESONANCE OSCILLATIONS OF A NONUNIFORM HOT PLASMA IN AN EXTERNAL FIELD. Barston, E. M. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev., 139: A394-400(July 19, 1965).

The frequency spectrum of a hydrodynamic model of a finite, warm, nonuniform plasma in an arbitrary external electric or magnetic field is considered. It is found that the spectrum is real and the system stable, for an arbitrary configuration. A variational principle is given for estimating the eigenfrequencies. First-order perturbation theory is applied to a cylindrical plasma, and formulas are obtained for the first-order correction to the eigenfrequencies (resonances) for the case of an applied magnetic field or transverse electric field, arbitrary electron density $n_{00}(r)$, and arbitrary angular dependence $e^{i\mu\theta}(\mu = 0, \pm1, \pm2, \ldots)$, the effect of the applied fields on the zero-order electron density being included. It is found that for $\mu \neq 0$, the modes have a twofold degeneracy, and that a uniform axial magnetic field splits the resonances in two. The first-order correction to the resonances is found to vanish for a uniform transverse electric or magnetic field. These results are discussed relative to other models and to experiment and appear to be in agreement with the available experimental data for the behavior of the main dipole resonance in both transverse and axial magnetic fields. (auth)

37969 X-RAY SCATTERING FROM AN ELECTRON GAS. Platzman, P. M. (Bell Telephone Labs., Murray Hill, N. Y.); Tzoar, N. Phys. Rev., 139: A410-14(July 19, 1965).

It is shown that the x-ray scattering from an electron gas in the large-momentum-transfer regime ($k \gg P_F/\hbar$) is a direct measure of the one-dimensional momentum distribution of the particles (including correlations). If the recoiling electron's momentum is measured in coincidence with the scattered x ray, then one can (in principle) measure the complete three-dimensional momentum distribution function. (auth)

37970 INTERACTION OF SOLITONS IN A COLLISIONLESS PLASMA AND THE RECURRENCE OF INITIAL STATES. Zabusky, N. J. (Bell Telephone Labs., Whippany, N. J.); Kruskal, M. D. Phys. Rev. Letters, 15: 240-3(Aug. 9, 1965).

Nonlinear interactions among solitary wave pulses propagating in nonlinear dispersive media were observed in the numerical solution of the Korteweg-deVries equation. This equation can be used to describe the one-dimensional, long-time asymptotic behavior of small, but finite amplitude shallow-water waves, collisionless-plasma magnetohydrodynamic waves, and long waves in anharmonic crystals. Also the interaction and focusing in space-time of the solitary-wave pulses permits a phenomenological description of the near recurrence to the initial state in numerical calculations for a discretized weakly nonlinear string. Spacially periodic numerical solutions of the Korteweg-deVries equation were obtained with a scheme that conserves momentum and almost conserves energy. (J.F.P.)

37971 INFORMATION THEORY AND VARIATIONAL PROPERTIES OF A STRONGLY INHOMOGENEOUS COLLISIONLESS PLASMA. Minardi, E. (EURATOM-FOM Association, Rijnhuizen, Jutphaas, Netherlands). Physica, 31: 585-96(Apr. 1965).

All solutions describing the electric field of a collisionless Maxwellian or non-Maxwellian one-dimensional plasma

at stationary equilibrium in a box can be obtained from the requirement that the electrostatic energy has an extremum value under the constraint that $I = -\Sigma_i \int_{\Delta x_i} G_i(n)\,dx$ be given, where the $G_i(n)$ are any given functions of the density n(x), each $G_i(n(x))$ being defined for x in the interval Δx_i delimited by the zeros of dn/dx or by the walls of the box. The functions G_i may be chosen in an arbitrary way, which is in agreement with the occurrence of an arbitrary function in the most general solution of the relevant mathematical equations. The quantity I describes the information which is necessary for a complete description of the electric properties of the physical system. (auth)

37972 PROPAGATION COEFFICIENT FOR THE CURRENT DISTRIBUTION ALONG A CYLINDRICAL ANTENNA IMMERSED IN A WARM PLASMA. Seshadri, S. R. (Sylvania Electronic Systems, Waltham, Mass.). Proc. Inst. Elect. Engrs. (London), 112: 877-82(May 1965).

The possibility of obtaining an estimate of the propagation coefficient for the current distribution along a cylindrical antenna immersed in a warm plasma was investigated. For this purpose, an infinitely long, perfectly conducting cylinder immersed in an unbounded, homogeneous and lossless plasma was considered. The dispersion equation for the propagation coefficient along the wire was obtained by using the differential equations that govern the small-amplitude wave motions in a warm plasma and approximate boundary conditions. Since antennas are usually excited by circularly symmetric voltage sources, the waves that are excited are also circularly symmetric, leading to the necessity of solving the dispersion equation only for circularly symmetric case. The solution of the dispersion equation for the propagation coefficient along the wire is obtained numerically for the circularly symmetric case for various radii of the wire. It was found that real values of the propagation coefficient are obtained for all frequencies. For the frequency range in which the space waves of both the electromagnetic and the plasma modes are excited, namely above the plasma frequency, the propagation coefficient along the wire was found to be nearly equal to that of the plasma wave. (TCO)

37973 THE PRODUCTION OF HIGH TEMPERATURE PLASMAS BY INTENSE LASER PULSES. Tozer, B. A.; Smy, P. R.; Wright, J. K. (Central Electricity Research Labs., Leatherhead, Eng.). Proc. Phys. Soc. (London), 86: 45-51(July 1965).

The possibility of producing dense high temperature plasmas by heating magnetically contained plasma with a pulsed laser beam is considered. The process requires high ion densities ($> 10^{17}$ cm^{-3}) to be maintained during the heating period, and the magnetic field strength required to contain such a plasma has been calculated in terms of both the kinetic pressure and Bohm diffusion of the plasma. Radiation and conduction losses from the plasma are also considered, and it is concluded that temperatures of the order of 10^6 °K should be obtainable within present-day limits of field strength and photon flux. To attain the conditions necessary for a fusion reactor with net power output, using a hydrogen isotope, laser energies greater than 10^4 J for a single passage of the radiation through the plasma and magnetic field strengths greater than 10^8 gauss are required if the plasma is formed from a hydrogen pellet in vacuo. The magnetic field strength has been calculated on the assumption that Bohm diffusion will be the most severe plasma loss mechanism. If the plasma is formed in a gas, a total laser energy of greater than 10^{11} J is required at a power greater than 10^{18} w. Any possible future development of a high-powered ultra-violet laser will make the use of high magnetic fields unnecessary provided sufficiently short laser pulses can be obtained. In this case there is no difference between the results obtained for the vacuum- or for the gas-encased model. In each case laser energies greater than 10^6 J at powers greater than 10^{15} w are required. The vacuum-encased model, with strong magnetic field, is identical with that at ruby laser frequencies. (auth)

37974 ELECTROMAGNETIC WAVES IN A PLANE WAVEGUIDE CONTAINING NONUNIFORM ISOTROPIC PLASMA. Ginzburg, V. M.; Maripov, A. Radiotekhn. i Elektron., 10: 868-78(May 1965). (In Russian)

A method is given for calculating the constant of electromagnetic wave propagation in a laminated waveguide containing inhomogeneous plasma with above critical electron concentration along the axis. The possibility of using the method in calculations for a rectangular waveguide with a circular discharge tube was analyzed. Formulas were derived for calculating the distribution of the amplitude and the field phase according the waveguide cross section and an example is given of the use of formulas for determining the small and post-critical concentrations in the center of the discharge. (tr-auth)

37975 INTERACTION OF CHARGED PARTICLES WITH TURBULENT PLASMA IN A MAGNETIC FIELD. Akhiezer, I. A. (Inst. of Physics and Tech., Kiev). Ukr. Fiz. Zh., 10: 581-5(June 1965). (In Ukrainian)

Interaction of charged particles with a turbulent plasma in a magnetic field is considered. The plasma is assumed to consist of cold ions and hot electrons moving through the magnetic field with a velocity v exceeding the sound velocity. The energy P transferred by the particle to the plasma per unit time is determined. The dependence of P on v is shown to be unaffected by the details of the turbulence spectrum. (auth)

37976 LIGHT MIXING IN FINITE PLASMA VOLUME. Salat, A. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Z. Naturforsch., 20a: 689-95(May 1965). (In German)

A third order scattering process of laser light in a fully ionized plasma is considered, extending previous work by Kroll, Ron, and Rostoker. Two laser beams may cause the plasma to oscillate with relatively high amplitude if the difference of their frequencies approaches the electron plasma frequency. The light of either one of the beams or of a third beam may be scattered by the induced fluctuations. The plasma is described macroscopically by a cold electron fluid. Special emphasis is given to the finite dimensions of the scattering volume. The results give detailed information about the angular width and intensity of the scattered light. Marked differences in the use of a two and a three laser system are pointed out, the former giving less intensity, the later being more difficult to realize experimentally. (auth)

37977 EXCITATION OF ELECTROMAGNETIC WAVES IN PLASMAS IN AN EXTERNAL ELECTRIC FIELD. Bakanov, S. P.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 1656-68(June 1965). (In Russian)

The excitation of low-frequency electromagnetic waves in a weakly ionized electron-ion plasma or electron-hole plasma of a solid body in the presence of an external electric field is investigated. An expression for the dielectric permeability of a plasma medium is derived by solving the kinetic equation involving the collision integral introduced by Davydov. The dispersion equation for small oscillations is analyzed in detail. (auth)

37978 PARAMETRIC RESONANCE IN A PLASMA. Silin, V. P. (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 1679-91(June 1965). (In Russian).

The conditions for appearance of parametric resonance in a plasma in an external periodic electric field are ascertained. The largest oscillation build-up increment, which by order of magnitude is equal to the product of the cube root of the ratio of electron to ion mass and the electron Langmuir frequency, arises for wave lengths comparable to the electron oscillation amplitude in the external field when the external frequency or its overtones approach the electron Langmuir frequency. For the same wave lengths, but far from resonance on external frequency overtones, the external frequency being assumed smaller than the electron Langmuir frequency, the oscillation build-up increment is of the order of magnitude of the Langmuir frequency. If the ratio of the electron oscillation amplitude to the oscillation wave length is small compared to unity,

the order of magnitude of increment decrease is determined by the same ratio in the two-thirds power. (auth)

37979 ON THE TRANSFORMATION OF LONGITUDINAL WAVES INTO TRANSVERSE WAVES IN A WEAKLY TURBULENT PLASMA. Suramlishvili, G. I. Zh. Eksperim. i Teor. Fiz., 48: 1732-9(June 1965). (In Russian)

A method is developed for deriving the matrix elements encountered in the collisional terms of the kinetic equations for waves in a plasma. The total Lagrange function for a non-collisional plasma is the basis of the method. The three-wave processes of two longitudinal waves forming a single transverse wave or the disintegration of a transverse wave into two longitudinal ones are considered. The rate of growth of the energy density of transverse waves produced as a result of mergence of Langmuir oscillations or of Langmuir and ion-sound waves in an isotopic homogeneous weakly turbulent plasma is calculated by employing the matrix elements found by the method discussed. (auth)

37980 SURFACE WAVES IN PLASMA WITH A CURRENT. Mikhailovskii, A. B.; Pashitskii, E. A. Zh. Eksperim. i Teor. Fiz., 48: 1787-95(June 1965). (In Russian)

Surface oscillations in a bounded cold plasma with charged-particle currents moving along a stationary magnetic field are considered. A sharp plasma boundary is assumed such that the oscillation wave length be much greater than the thickness of the transition layer. General boundary conditions are derived for joining the solutions in the layer which may be used for obtaining the oscillation dispersion equations for various particular cases. It is shown that in the presence of particle beam slanting ($k_z \gg k_x$), surface waves are unstable; and, as a result, the sharp plasma boundary smears out. (auth)

37981 KINETIC DESCRIPTION OF RAREFIED FULLY IONIZED PLASMA. Dyukalov, A. N. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 6, 39-49(Nov.-Dec. 1964). (In Russian)

The system of Vlasov equations is usually used for the description of rarefied plasma. It was shown previously that this system can not completely describe the processes in the plasma. A method of constructing solutions, previously applied to the very simple plane case, is generalized to the broad class of problems which are conveniently described as problems with emitting surfaces. (tr-auth)

37982 ON THE MOTION OF PLASMA BURSTS IN FIELD FREE SPACE. Azovskii, Yu. S.; Guzhovskii, I. T.; Mazalov, Yu. P.; Pistryak, V. M. Zh. Tekhn. Fiz., 35: 643-9(Apr. 1965). (In Russian)

The velocities of plasma bursts from a conical plasma gun were measured by means of the Doppler effect. Two different frequencies were employed (3.2 and 9.0 Gc/sec); the measured velocities therefore correspond to the motions of two different density regions within the burst. The plasma bursts were produced by the 28-kv discharge of a 27-μfd capacitor through a conical plasma gun containing approximately 3 cm^3 of hydrogen, and traveled in a 9-cm-diameter, 50-cm-long glass tube and subsequently in a 18-cm-diameter, 200-cm-long plastic tube. The measured motions of the two particle density regions (1.1×10^{11} and 1.1×10^{12} cm^{-3}) are presented graphically. A theory of a freely expanding plasma is briefly developed for both the one- and three-dimensional cases. This theory was employed to calculate from the measured velocities the velocity of the center of gravity of the burst and the sum of the ion and electron temperatures. Because of the uncertainty concerning several factors involved in the calculation, the calculated value of 5 ev for the sum of the electron and ion temperatures is regarded as in satisfactory agreement with the value of 8 ev previously obtained for the electron temperature in similar plasma bursts from the intensity ratio of the HeI 4921 and HeI 4713 lines. (ATD)

37983 INVESTIGATION OF THE STRUCTURE OF SHOCK WAVES IN AN ELECTROMAGNETIC SHOCK TUBE. Makarov, Yu. V.; Maksimov, A. M. (State Scientific Research Power Engineering Inst., Moscow). Zh. Tekhn. Fiz., 35: 650-7(Apr. 1965). (In Russian)

In a previous investigation of shock waves in electromagnetic shock tubes evidence was obtained for the inferences that the region of maximum luminosity behind the shock front is due to a gas discharge plasma (and not to relaxation of the gas heated by the shock front) and that for low-intensity shock waves, the weakly luminous shock front outruns the region of maximum luminosity. More detailed experiments to test and extend these conclusions are reported. The principal innovation in the present work was the use of a barium titanate piezoelectric transducer in order to register the passage of the shock front. The luminous phenomena accompanying the shock wave were observed with several photomultipliers, and the radiation in discrete spectrum lines was observed with a photomultiplier coupled to a monochromator. The shock waves were produced by electrical discharge in a conical tube and were propagated in air at pressures up to several mm Hg in a cylindrical tube. The previous conclusions were confirmed, and it is asserted that the interpretation by Blackman and Niblett of phenomena accompanying reflection of shock waves in terms of a relaxation zone must be regarded as erroneous. It was found that when $M_s > 30$ the shock front leads the luminous front (gas discharge plasma) by less than 0.3 μsec; and when $M_s < 28$, there is an appreciable region of shock-heated gas between the shock front and the more luminous gas discharge plasma. The gas discharge plasma behind the weaker shock waves is unstable, and appreciable mixing of it with the shock-heated gas occurs. (ATD)

37984 SPECTROSCOPIC INVESTIGATIONS WITH AN ELECTROMAGNETIC SHOCK TUBE. Makarov, Yu. V.; Maksimov, A. M. (State Scientific Research Power Engineering Inst., Moscow). Zh. Tekhn. Fiz., 35: 658-66(Apr. 1965). (In Russian)

The results of spectroscopic investigations with a shock tube are reported, in which air was used as the working medium. With the aid of a monochromator, a photomultiplier, and an oscilloscope, the time variation of intensity as the shock wave passed the observation point was recorded for a number of spectrum lines of H, O, Cu, and other elements, and for a number of wavelengths in the continuum. As both the air pressure in the shock tube and the strength of the electrical discharge producing the shock wave were varied over rather wide ranges, a great many data appear to have been collected. Only a few of these data are presented directly, but many of them are discussed in some detail. Most of the visible radiation was found to originate in the gas discharge plasma behind the shock front. Under most conditions the gas discharge plasma followed the shock wave very closely, and its luminosity made it impossible to investigate the state of the working gas immediately behind the shock front. Under some conditions, however, the shock wave outruns the gas discharge plasma, and an investigation of the state of the gas behind the shock front under these conditions is promised for the future. The electron concentration in the gas discharge plasma varied from 10^{15} to 10^{17} cm^{-3} and depended strongly on the initial conditions (air pressure and discharge voltage); the electron temperature was about 6000°K and was almost independent of the initial conditions. (ATD)

37985 CONVERSION OF TWO TRANSVERSE WAVES INTO A LONGITUDINAL WAVE IN A PLASMA WITHOUT COLLISIONS. Danilkin, I. S. (Lebedev Inst. of Physics, Moscow). Zh. Tekhn. Fiz., 35: 667-76(Apr. 1965). (In Russian)

It is shown that two transverse waves propagating in a plasma can give rise to a longitudinal wave with a frequency equal to the difference between the frequencies of the transverse waves and that the conversion is appreciable provided the difference frequency is close to the electron Langmuir frequency. Collisions and the motion of the ions are neglected; the system is accordingly described by the kinetic equation for the electron distribution function and Maxwell's equations for the fields. These equations are simplified by retaining in the distribution function only terms that are linear or quadratic with respect to the electric field strength. A system of coupled amplitude equations is derived for the amplitudes of two plane transverse waves and

a longitudinal wave at the difference frequency. This system is identical in form with those derived elsewhere. The conversion from transverse to longitudinal waves proceeds most rapidly when the electric vectors of the two transverse waves are parallel; when the electric vectors are perpendicular there is no conversion in the present approximation. Approximate formulas are derived for the characteristic length for the conversion of the transverse to longitudinal waves. It is suggested that the conversion process investigated here may be useful for exciting longitudinal waves in plasma systems. (ATD)

37986 DEVELOPMENT OF A FAST PARTICLE BEAM PLASMA PROBING TECHNIQUE FOR INVESTIGATING PLASMA BURSTS. Krupnik, L. I.; Shulika, N. G.; Demchenko, P. A. Zh. Tekhn. Fiz., 35: 711-16(Apr. 1965). (In Russian)

The particle density in highly ionized plasma bursts was previously determined by measuring the decrease in the intensity of a hydrogen atom beam occasioned by its traversing the plasma. This method is extended to the case in which the degree of ionization is not known, is not necessarily large, and is to be determined along with the density. The requisite additional information is obtained by employing two particle beams (or a single composite beam) either of atoms of different energies or of atoms and ions. Measurements of hydrogen plasma bursts were performed. In one set of experiments, hydrogen plasma bursts from a conical plasma gun were traversed by a beam containing both hydrogen atoms and hydrogen ions. The beam was obtained from a proton beam by charge-exchange collisions in a gas chamber, and the separate constituents were detected by the method of Afrosimov involving production of secondary electrons on targets, plastic scintillators, and photomultipliers. After passage of the highly ionized head of the burst, the ionization fell to 20%, then increased to a second maximum of 30% just before the region of maximum density, and subsequently decreased monotonically. The particle density was also measured with an electrostatic probe; the probe and particle beam measurements were in good agreement. Experiments were also performed with beams of 4- and 12-kev hydrogen atoms. These experiments are said also to have given satisfactory results, but they are only briefly described. Probe beams containing both atoms and ions are preferable to those containing only atoms of different energies, but they can not be employed when the plasma burst moves in a magnetic field. The cross sections for all the interaction processes between the probe-beam and plasma particles must be known; this condition is met when a hydrogen plasma is probed with a hydrogen beam. (ATD)

37987 INVESTIGATION OF THE PROPERTIES OF A PLASMA IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Shvets, O. M.; Ovchinnikov, S. S.; Tarasenko, V. F.; Tolok, V. T. Zh. Tekhn. Fiz., 35: 717-22(Apr. 1965). (In Russian)

The behavior of a hydrogen plasma was investigated in crossed radial electric and longitudinal magnetic fields. The plasma was contained in the 180 cm long annular space between two coaxial copper cylinders of diameter 1.6 and 12.2 cm. The radial electric field was produced by discharging a 1050 μfd capacitor across the two copper cylinders, and a longitudinal magnetic field up to 2500 gauss was produced by 24 water-cooled coils. Hydrogen was admitted, and the system was pumped continuously. During the operating cycle the current through the plasma and the potential across it were recorded. The luminosity was recorded with a photomultiplier, and there was a magnetic probe within the working volume. At the end of the operating cycle the plasma was short circuited with a spark gap. Two successive maxima of the luminous intensity were observed; the first is ascribed to local arc breakdown and the second to the formation of an electron zone near the anode. The plasma was found to remain in stable rotation for 650 to 1000 μsec. The duration of the stable rotation was nearly independent of the pressure, magnetic field strength, and capacity and charge of the capacitor bank, and was of the order of the time required for the magnetic field due to the plasma currents to penetrate the conducting wall of the chamber. It is concluded that during the stable period the plasma is confined by the magnetic field and that the duration of stable rotation could be greatly increased by increasing the conductivity of the chamber wall. Experiments to test this conclusion by cooling the wall of the chamber are under way. It is suggested that plasmas in crossed fields may find practical application in the construction of noninductive capacitors and high-power switching devices. (ATD)

37988 INVESTIGATION OF THE INFLUENCE OF A TRANSVERSE MAGNETIC FIELD ON A LOW-VOLTAGE CESIUM VAPOR ARC. Bondarenko, I. I.; Gus'kov, Yu. K.; Lebedev, M. A. Zh. Tekhn. Fiz., 35: 751-8(Apr. 1965). (In Russian)

The effect of a transverse magnetic field (up to 370 gauss) on the operation of low-voltage cesium vapor arc between hot stainless steel electrodes was investigated. The electrodes were hollow cylinders 18 mm in diameter, and their closed ends were separated by 6 mm. The electrodes were heated by internal nichrome heaters, and the temperatures of the ends were measured with thermocouples. In most of the experiments, the cathode temperature was 800°C, and the anode temperature was 350°C. The tubes were baked out on the pumps and sealed off at $1-2 \times 10^{-7}$ mm Hg. A tube was discarded when its ignition and burning potentials began to increase. The cesium vapor pressure was controlled by heating a branch tube containing cesium. The magnetic field was produced by two 14 cm diameter coils separated by 14 cm. The ignition potential and the current-voltage characteristics were determined as functions of the cesium vapor pressure and magnetic field strength; the results are presented graphically and discussed at some length. For cesium pressures above the critical value, good agreement was found with the theory of Haefer when the ionization energy of cesium was assumed to be 1.35 ev, which is close to the excitation energy of an excited cesium atom. This agreement is regarded as further evidence that ionization of cesium in the low-voltage arc proceeds in a stepwise manner. Significant deviations from the theory were observed at low pressures. (ATD)

37989 NONLINEAR GENERATION OF PLASMA WAVES BY A BEAM OF TRANSVERSE WAVES. [PART] I. Tsytovich, V. N. (Inst. of Physics, Moscow). Zh. Tekhn. Fiz., 35: 773-87(May 1965). (In Russian)

The generation of plasma waves by a beam of high-frequency transverse waves traversing a plasma is discussed for the case of a weakly turbulent plasma. The underlying theory has been developed in a previous paper. The instability of the transverse waves is discussed, and the nonlinear effects involved are analyzed. The decay of a beam of transverse waves into plasma waves with the same propagation direction is discussed both for a monochromatic beam and for a beam with a wide frequency distribution. In the case of a monochromatic beam, the nonlinear effects cause the appearance of satellites at frequencies differing from that of the primary by multiples of the Langmuir frequency. The relative intensities of these satellites depend on the condition of the plasma and can be employed for diagnostic purposes. It is found that the nonlinear transformation of high-frequency waves to plasma waves contributes considerably to the absorption by the plasma of high-frequency energy. (ATD)

37990 NONLINEAR DAMPING OF LOW FREQUENCY PLASMA WAVES. Ramazashvili, R. R.; Tsintsadze, N. L. Zh. Tekhn. Fiz., 35: 788-93(May 1965). (In Russian)

The damping constant (logarithmic decrement) of the low-frequency plasma waves in a nonisothermal plasma, which have a phase velocity intermediate between the electron and ion thermal velocities is calculated. The calculation is performed for waves of finite amplitude A, but for which eA is much less than T_e, where e is the electron charge and T_e is the electron temperature. Only the kinetic equation for the electron distribution function is considered. The collision integral given by Silin is used, in which the

effect of the polarization of the medium is taken into account. In its final form this collision integral contains two terms, of which one takes account of close collisions (collision parameter less than the Debye radius), while the other describes the collective effects. The kinetic equation for the electron distribution function in the presence of the plasma wave is identical with that used by Zakharov and Kapman in their nonlinear discussion of high-frequency plasma waves, and further deductions from it are adapted to the present problem. It is found that the damping constant for the low-frequency plasma waves is proportional to A^{-5} and is much less than that given by the linear theory. For $T_e/T_i > 100$ (T_i is the ion temperature), the effect of the collective interactions is greater than that of the two-body collisions. (ATD)

37991 EXCITATION OF MAGNETOACOUSTIC WAVES BY A MOVING SOURCE. Dokuchaev, V. P.; Logacheva, V. D. Zh. Tekhn. Fiz., 35: 794-802(May 1965). (In Russian)

The radiated energy spectrum and the radiation drag are calculated for the radiation of magnetoacoustic waves in a magnetized plasma by an oscillating ring current or an acoustic monopole moving at a constant velocity parallel to the external magnetic field. The calculations are based on the linearized magnetohydrodynamic equations and are performed by the method of Bolotovskiy, using the Fourier-Hankel transformation. The "acoustic monopole" is represented as a sinusoidally varying mass source (and sink). The calculation is performed only for the case of the normal Doppler effects. When the velocity of the source exceeds the phase velocity of the radiated waves, the expressions obtained for the radiated energy and the drag diverge; and in order to achieve convergence it becomes necessary to take into account dissipative processes of viscosity and electroconductivity. The spectral distributions of the radiated energy and the radiation drag are found to differ. Both the radiated energy and the drag increase with increasing source velocity. The integrations over the spectral distributions are performed, and closed expressions are obtained for the total power radiated and the total drag for the two limiting cases that the velocity of sound is either much greater or much less than the Alfven velocity and only the slow magnetoacoustic waves are radiated. (ATD)

37992 MAGNETOHYDRODYNAMIC WAVES IN A PLASMA IN THE PRESENCE OF A BEAM OF CHARGED PARTICLES. Bogdanov, A. V. (Moscow Regional Pedagogical Inst.). Zh. Tekhn. Fiz., 35: 803-8(May 1965). (In Russian)

The propagation of fast magnetoacoustic waves in the presence of a neutral beam of charged particles with collisions is discussed, taking into account the rotation of the ions. The calculations are based on the linearized kinetic equations for the plasma and the beam with collisions treated in the manner of Bhatnagar, Gross, and Krook (Phys. Rev., 94: 511(1954)). The general treatment is that proposed by Braginskiy and Kazantsev. The dispersion equation for low-frequency, magnetohydrodynamic waves propagating at an arbitrary angle to the external magnetic field is derived with the assumption that all the frequencies involved are small compared with the ion Larmor frequency. Collisions and the difference between the electron and ion temperatures do not affect the dispersion of Alfven waves in the first approximation. The solutions of the dispersion equation for fast magnetoacoustic waves are discussed separately for a rarefied and for a dense plasma, and the condition for plasma stability is derived. The number of degrees of freedom of the ions is carried throughout as a parameter; the results are accordingly directly applicable to the cases of uni-, di-, and polymolecular ions in which vibrations are not excited. (ATD)

37993 INVESTIGATION OF A HIGH FREQUENCY RESONANT DISCHARGE IN CROSSED FIELDS. Ganichev, D. A.; Fridrikhov, S. A.; Ashkinadze, B. M.; Solgan, A. B. (Leningrad Polytechnical Inst.). Zh. Tekhn. Fiz., 35: 813-22(May 1965). (In Russian)

High-frequency resonant discharge was investigated in the presence of a magnetic field because of the importance of the phenomenon for magnetrons and other high-frequency equipment and the paucity of such studies in the literature. The discharges were produced in a silver-plated oxygen-free copper rectangular waveguide section of dimensions 25.5×12.5 or 28.5×4 mm by 1 μsec pulses of 3 cm wavelength H_{10} waves at a repetition rate of 10^3 sec^{-1}. The applied magnetic field was perpendicular to the narrow wall of the waveguide, and in the wide wall were introduced two probes (with aquadag-coated electrodes to minimize secondary emission) and a hot cathode. Hydrogen was admitted to the continuously pumped waveguide section. With the uhf oscillator operating at a controlled power level (up to 200 kw/pulse) the magnetic field was gradually increased to 6000 gauss; and the probe currents, the uhf attenuation, and the luminous intensity were observed. The shape of the individual light pulses was also observed with a wide-band amplifier and an oscilloscope. In addition to the uhf intensity (electric field strength) and the magnetic field strength, the residual hydrogen pressure was varied over a wide range. Many of the results are presented graphically and are discussed in some detail. At pressures from 5×10^{-4} to 5×10^{-2} mm Hg, resonant discharges with ionization of the residual gas were observed at the two values of the magnetic field for which the electron Larmor frequency was equal to the uhf frequency or to half the uhf frequency. At pressures above 10^{-2} mm Hg, a third resonance was observed at a Larmor frequency one-fourth the uhf frequency. These resonant discharges occurred only for uhf electric field strengths exceeding a threshold value that depended on the gas pressure. The probe current increased rapidly with increasing pressure and reached a maximum at about 3×10^{-3} mm Hg. (ATD)

37994 INVESTIGATION OF SOME PROPERTIES OF A PLASMA CAPTURED BY A TRANSVERSE MAGNETIC FIELD. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G.; Safronov, B. G., Sinel'nikov, K. D. (Physico-Technical Inst., SSSR). Zh. Tekhn. Fiz., 35: 823-6(May 1965). (In Russian)

It was previously found that a portion of the plasma injected into a transverse magnetic field is captured by the field and moves parallel to it. This phenomenon was investigated further using an apparatus similar to that previously employed, but larger. In the present apparatus the longitudinal magnetic field is maintained in a 12 cm diameter, 300 cm long drift tube; with the plasma transversely injected at the center of the drift tube, the motion of the captured plasma could be followed for 120 cm. The polarization of the captured plasma was observed with probes. After a decrease of 20 to 50% in the first 30 or 40 cm, the polarization decreased only very slowly with distance from the injection point. The expected drift of the captured plasma in the crossed fields (the electric field due to polarization and the applied magnetic field) was observed with the aid of a slotted plastic diaphragm and a "plasmascope." The effect of shorting out the plasma polarization with a copper disk was investigated; this was to inhibit the transverse motion of the captured plasma. (ATD)

37995 THE MAGNETIC MOMENT OF A PLASMA BURST ENTERING A UNIFORM MAGNETIC FIELD. Khizhnyak, N. A. Zh. Tekhn. Fiz., 35: 833-46(May 1965). (In Russian)

The behavior of a plasma burst entering an axially symmetric magnetic field is discussed for the limiting cases of a rarefied and a dense plasma. The calculations are based on the "flexible current loop" model, the equations for which are obtained from the magnetohydrodynamic equations by integrating in Lagrange variables over the volume of the plasma. Collisions and thermal motions of the plasma particles are neglected. The magnetic moment and variation of the radius and length of the plasma are calculated for simple assumptions concerning the variation of the magnetic field in the region in which it increases from zero to its final uniform value. In the case of a rarefied plasma, the relative change of the magnetic field due to the plasma current is negligible; and each plasma particle moves in the unperturbed field. In the case of a dense

plasma the magnetic field is almost entirely expelled from the plasma by the induced currents. As a dense plasma enters a strong magnetic field, the induced magnetic moment rises to a maximum and then decreases as a result of collapse of the plasma. The effects of thermal motions and collisions are discussed in a final section, and equations are derived with the aid of which these effects can be calculated numerically. (ATD)

37996 MOTION OF A FINITE PLASMA IN THE MAGNETIC FIELD OF A TOROIDAL SOLENOID. Khizhnyak, N. A. Zh. Tekhn. Fiz., 35: 847-57(May 1965). (In Russian)

The motion of a plasma of finite extent in a magnetic field with curved lines of force, such as is produced by a toroidal solenoid, is discussed. The discussion was undertaken because it has been found that under suitable conditions the plasma will follow the curved lines of force (and lose heavy impurity ions in the process), whereas Schmidt (Phys. Fluids, 3: 961(1960)) has shown that the equations of motion in the drift approximation predict that it will not. The equations of motion for a single charged particle in an axially symmetric field having only an azimuthal component are first solved, and the motion of a rarefied plasma is discussed on the basis of this solution. It is found that the rarefied plasma tends to follow the lines of force and that under suitable conditions of velocity, field strength, and field curvature, the plasma will lose heavy impurity ions to the walls of the container. To discuss the motion of a dense plasma, the equations of the drift approximation are used with an additional term representing a current in the plasma parallel to the plasma polarization. The interaction of this current with the magnetic field tends to cause the plasma to follow the curvature of the field. This current is assumed to be due to short circuiting of the plasma polarization potential by that portion of the plasma that is still in a region of uniform field and is therefore not polarized. The supplementary term in the equations of motion is evaluated on the basis of this assumption and the additional assumption that the plasma is perfectly conducting parallel to the magnetic lines of force (but not perpendicular to them), and the exact equations of motion for the present model are obtained. These equations are not solved, but the nature of their solutions is discussed at some length, and it is concluded that the equations are capable of accounting at least qualitatively for the observed behavior of the plasmas. (ATD)

37997 INVESTIGATION OF THE OPERATION OF A COAXIAL PLASMA SOURCE UNDER CONDITIONS OF FAST PARTICLE PRODUCTION. Timofeev, A. D.; Marinin, V. G.; Shevchuk, B. A.; Kalmykov, A. A. Zh. Tekhn. Fiz., 35: 858-64(May 1965). (In Russian)

The operation of a coaxial plasma source was investigated experimentally. The stainless steel cylindrical electrodes were 5.4 and 2 cm in diameter, and the outer electrode was 25 cm long. After admission of 0.9 cm^3 of H_2 (or in some cases of He) by means of a fast-acting valve, the source was fired by the 20-kv discharge of a 4-μfd capacitor. The period of the discharge circuit was 3.2 μsec. After traversing a 10-cm-diameter, 1.5-m-long drift tube, the plasma was either collected in a calorimeter, or the velocity and mass distribution of its ions were determined with a mass spectrometer. It was previously found that when the delay between gas admission and firing of a coaxial plasma source is less than a certain critical value (which was approximately 300 μsec for the present apparatus), the plasma is emitted in two parts, of which the first has several times the velocity of the other. The present experiments were performed under these conditions of short delay. The plasmas were found to contain large numbers of iron and other foreign ions. The number of heavy ions decreased rapidly with increasing delay time, and under the conditions of most of the present experiments the numbers of hydrogen and iron ions in the plasma burst were of the same order of magnitude. The total number of hydrogen ions in the plasma burst, the mean energy of the hydrogen ions, and the total energy of the burst were determined as functions of the length of the inner electrode, and the results are compared with calculations based on the theory of Baranov and Musin in which the increase of the plasma mass during acceleration due to sputtering of the electrodes is taken into account. Good qualitative agreement was found. There was found to be an optimum electrode length at which the velocity of the plasma was a maximum and the energy of the capacitor was most efficiently transformed into kinetic energy of the plasma. (ATD)

37998 ON THE NONLINEAR THEORY OF LOW-FREQUENCY OSCILLATIONS EXCITED IN A PLASMA BY AN ION BEAM. Lominadze, D. G.; Shevchenko, V. I. Zh. Tekhn. Fiz., 35: 865-74(May 1965). (In Russian)

The excitation of long-wavelength low-frequency oscillations in a plasma by an ion beam in the presence of a magnetic field is investigated, together with the excitation of longitudinal oscillations at harmonics of the ion Larmor frequency. The initial stage of the developing instability, in which the ion beam remains essentially monoenergetic, is treated in a hydrodynamic approximation in which the system is described by the moments of the distribution functions. The later stages, in which a considerable velocity dispersion develops in the ion beam, are treated in a quasi-linear approximation. The energy loss of the ion beam is calculated, and it is found that a considerable fraction of the energy lost by the beam can appear as thermal energy of the plasma ions. (ATD)

37999 ON THE CHANGE IN THE DISCHARGE MECHANISM IN AIR AT ATMOSPHERIC PRESSURE WHEN THE GAP LENGTH BETWEEN PLANE ELECTRODES IS INCREASED. Aleksandrov, G. N. (Leningrad Polytechnic Inst.). Zh. Tekhn. Fiz., 35: 875-82(May 1965). (In Russian)

The breakdown of air at atmospheric pressure in a uniform electric field and the formation of a self-sustaining discharge is discussed with particular reference to the role of photoelectric processes. The purpose of the discussion is to elucidate the transition from the classical Townsend mechanism to the streamer formation mechanism. Calculations of the effect on the development of the discharge of photoelectrons released from the cathode by photons produced in the primary avalanche are compared with experimental data of Ritz and others. It is concluded that at gap lengths up to 2 cm, the distortion of the field by the space charge of the initial avalanche is negligible and the relation between breakdown potential and gap length can be explained with the aid of the photoelectric effect. In longer gaps the space charge of the initial avalanche strongly distorts the field and leads to streamer formation. In the longer gaps the total number of electrons in an avalanche cannot be correctly estimated without taking account of field distortion by the space charge. (ATD)

38000 ON THE PASSAGE OF ELECTRODE MATERIAL INTO THE GAS CLOUD SURROUNDING A SPARK DISCHARGE. Palatnik, L. S.; Levchenko, A. A. (Kharkov Polytechnic Inst.). Zh. Tekhn. Fiz., 35: 883-8(May 1965). (In Russian)

Sparks between identical binary alloy electrodes or different pure metal electrodes were investigated, and the ratio of the concentrations of the two electrode metals in the gas cloud surrounding the spark were determined spectroscopically. Co–Ni, Co–Cu, and Pt–Ag alloys were studied. In the case of the Co–Ni alloys, which were solid solutions, the relative concentration of Ni and Co in the vapor phase was roughly the same as in the solid phase and was constant in time. The results obtained with the other metals were less simple and are discussed in some detail. It is concluded that in the case of single-phase alloys the composition of the gas is determined by selective vaporization at the anode, that in other cases selective erosion of the separate phases at the cathode is also involved, and that changes in time of the gas composition are due to changes in the composition of the surface layers of the electrodes resulting from selective vaporization, selective erosion, transfer of material from one electrode to the other, or a combination of these processes. (ATD)

38001 ON THE EQUILIBRIUM OF PLASMA IN A MAGNETIC TRAP. Popryadukhin, A. P. Zh. Tekhn. Fiz., 35: 927-34(May 1965). (In Russian)

The position and velocity distributions of plasma electrons in different types of magnetic traps are discussed on the basis of the drift-approximation kinetic equation given by Sivukhin. The effects of collisions and electric fields are neglected. The distribution function is assumed to be independent of the phase angle of the particle in its Larmor orbit, and the remaining two velocity variables are replaced by two constants of motion that are closely related to the Braginskiy variables. The equilibrium density distribution depends on the distribution of one of these constants of motion, but not on that of the other; this is illustrated with several simple specific solutions. The current in the plasma is calculated, and the field due to this current is superimposed on the external field to give a self-consistent treatment. In the case of isotropic injection in the minimum field region, the resulting equations reduce, in the lowest order in the ratio of the velocity to the magnetic field strength, to the magnetohydrodynamic equations. The conditions for the existence of a set of closed trajectory surfaces is discussed briefly. (ATD)

38002 CONCERNING THE OSCILLATIONS OF AN ELECTRON-ION PLASMA IN A STRONG ELECTRIC FIELD. Liperovskii, V. A. (Inst. of Physics, Moscow). Zh. Tekhn. Fiz., 35: 958-61(May 1965). (In Russian)

When a plasma is held in a uniform electric field, the ions and electrons drift in opposite directions. The system becomes unstable when the drift velocity exceeds the thermal velocities and energy is lost to longitudinal oscillations. Buneman (Phys. Rev., 115: 503(1959)) and others have treated this problem with the aid of the dispersion equation for the case in which the product kE of the wave number by the electric field strength is small. The problem is discussed on the basis of the two-fluid hydrodynamic model for arbitrary values of kE with the assumption that the drifts are uniformly accelerated. A fourth-order differential equation is derived for the Fourier component of the electron density, from which the usual dispersion equation follows in the limit kE = 0. The correction due to drift acceleration to the usual expression for the logarithmic increment (the imaginary part of the frequency) is derived for small but finite values of kE. The increment is large when the drift velocity is close to the propagation velocity, but the system does not remain long in the resonance region and the total energy lost to the oscillations during passage through resonance decreases with increasing drift acceleration (electric field strength). Expressions are derived for the Fourier component of the electron density which are asymptotically valid for large kE. When E exceeds a critical value, the energy lost to the oscillations during passage through resonance is negligible. (ATD)

38003 ON THE DAMPING OF WAVES WITH PHASE VELOCITY GREATER THAN THE VELOCITY OF LIGHT. Kondratenko, A. N. Zh. Tekhn. Fiz., 35: 961-3(May 1965). (In Russian)

It is shown that in a bounded plasma, waves with phase velocity greater than c (the velocity of light) can be damped by interaction with the plasma electrons, although this is not the case in an unbounded plasma. An infinite plasma layer of thickness 2a between two conducting plates separated by a distance 2b > 2a is discussed, and waves propagating parallel to the layer are considered. From earlier work, a condition for resonance between the waves and the electron thermal motions is taken, in the derivation of which it was assumed that the plasma particles are specularly reflected at the boundaries of the plasma. It is asserted that this assumption is not essential. For a high phase velocity this condition reduces to v = 2fa/n, where v is the thermal velocity perpendicular to the layer, f is the frequency, and n is an integer. It is concluded that harmonics corresponding to large values of n will be strongly damped and that, since the harmonics can not propagate independently in the bounded plasma for geometric reasons, the wave will be damped. An expression for the impedance of the plasma is quoted from the earlier work, and a dispersion equation is derived from it. For frequencies close to the Langmuir frequency, this dispersion equation has a root describing waves with phase velocity greater than c. If b tends to infinity while a remains finite, the phase velocity of these waves approaches c. (ATD)

38004 ON DETERMINING THE VELOCITIES OF A GLOW DISCHARGE PLASMA IN A RECTANGULAR CHANNEL IN THE PRESENCE OF CROSSED FIELDS. Chermarev, I. B. (Leningrad Physico-Technical Inst.). Zh. Tekhn. Fiz., 35: 964-6(May 1965). (In Russian)

The velocity of a glow discharge plasma in an infinitely long rectangular channel of which two opposite walls are the electrodes is calculated. The electric field is assumed to be uniform; and a uniform magnetic field, perpendicular to the electric field and to the axis of the channel, is assumed to be present. The temperature of the neutral atoms is assumed to be equal to the ion temperature and much less than the electron temperature. The solution is sought in the form of a power series in the small Stewart and magnetic Reynolds numbers. The zero-order diffusion equations for the electron and ion gases are solved for the electron density and current distributions, and these quantities are used in the succeeding approximation to calculate the velocities. A closed expression is derived for the first-order longitudinal velocity, and a fourth-order partial differential equation is obtained for the first-order transverse velocity potential. This equation can be solved for the rectangular region by known methods. (ATD)

38005 A STUDY OF GUIDED ELECTROMAGNETIC WAVE BEAMS IN AN ANISOTROPIC PLASMA. Lonngren, Karl Erik. Thesis, Madison, Wis., Univ. of Wisconsin, 1964. 107p.

Problems concerned with extending the method of microwave transmission developed by Goubau and his associates to the case in which the medium between the equiphase planes is an anisotropic plasma are presented. The method used to calculate the fields in a plasma beam waveguide for one mode is a particularization of Hamilton's principle, which is a variational technique. It was found that the cross-sectional distribution for a plasma beam waveguide was given in terms of Hankel functions. The case studied assumed an infinite static magnetic field in the direction of propagation as well as a longitudinal component of electric field for the propagating mode. This technique was also applied to a beam waveguide in rectangular coordinates in free space and the complete field was found to be related to a Weber function. This function could be expanded in modes of products of Hermite polynomials and a Gaussian. The beam waveguide of circular cross-section was also related to oblate spheroidal coordinates in an explicit manner and the expected loss in the high-loss region is presented for various modes. It was concluded that the beam modes of a slightly different form are preserved when an anisotropic plasma is introduced. The phase correcting lenses can be eliminated since the infinite magnetic field guides the waves as in "Whistler" propagation. The feasibility of the plasma beam waveguide was demonstrated. (Dissertation Abstr.)

38006 MODE COUPLING IN BOUNDED, COLD BEAM-PLASMA SYSTEMS. Eidson, John Charles. Thesis, Stanford, Calif., Stanford Univ., 1964 133p.

The problem of guided wave propagation and electron beam interaction in bounded systems containing a plasma was studied. The model used in the study is a circular conducting guide partially filled with a uniform, stationary, zero-temperature plasma contained with a finite axial d-c magnetic field. For the electron-beam interaction study, the beam is assumed to be of uniform cross section and perfectly neutralized. The modes existing in such a system are studied from two points of view. First a detailed treatment using the quasi-static assumption is given. The second portion is directed at including the effects of the divergence-free fields that are neglected in the quasi-static approximation. A coupled mode approach and a variational technique are developed, which give results that approximate the exact solution quite closely and provide a good conceptual basis for understanding the effects of the

various system parameters on the propagation characteristics. A number of calculations using this theory are presented. The interaction of a neutralized electron beam with the modes in the finite plasma system is investigated by means of normal mode and variational techniques. These methods prove to be accurate in calculating the propagation constants of the combined beam-plasma system and reveal the nature of these interactions in a physically meaningful way. The status of the experimental verification of the propagation characteristics of the finite plasma system is reviewed. Further experimental results on the characteristics of the surface waves are discussed. Finally the results of an experiment using a thermal cesium plasma, which qualitatively verify the mode splitting and deformation predicted by the coupled mode theory, are presented. (Dissertation Abstr.)

38007 THE OPPOSITE-STREAM PLASMA DIODE. Burger, Peter. Thesis, Stanford, Calif., Stanford Univ., 1964. 135p.

The possible d-c states of a one-dimensional plasma diode are analyzed. This diode consists of opposing thermionic ion and electron emitters in parallel-plane geometry. The emitters can have different temperatures. Nonreflecting boundaries and a complete lack of collisions are assumed. Electrons and ions are assumed to be generated with half-Maxwellian velocity distributions corresponding to their respective temperatures. For the case of nonnegative potential of the ion emitter with respect to the electron emitter all possible d-c states are found. It is shown that if the continuity of the spatial derivative of the space-charge function is required in the diode space, then only one self-consistent d-c state is possible for a diode with a given applied potential across it. The d-c state is called the "basic solution." If discontinuities in this derivative are permitted, spatially periodic d-c states also become possible solutions for some diodes. The stability of the d-c states is examined by simulating the motions of the electrons and ions on a computer. The computer model shows that under time-varying conditions the basic solution is formed and that it is in qualitative and quantitative agreement with the results of the forementioned d-c calculations. When the periodic solution is set up in the diode model initially, it changes rapidly into the basic solution, showing that the discontinuous derivative of the space-charge function makes this d-c solution highly unstable. Characteristics of this computer diode and the step-by-step transformation of the periodic state are shown. An experimental model of the opposite-stream diode is constructed with a solid-state, thermionic, lithium ion emitter and a barium-oxide-coated electron emitter. The current-vs-voltage characteristics of this diode agree with the theoretical values predicted for the basic solution, if the contact potential of the emitters is taken into account. (A.G.W.)

38008 INTERFEROMETRIC STUDY OF THERMAL EQUILIBRATION IN A SHOCK-HEATED PLASMA. Wong, Howard. Thesis, Stanford, Calif., Stanford Univ., 1964. 96p.

The ionization mechanisms associated with the passage of strong shocks (to M = 18) through argon gas were studied. Optical interferometry used in conjunction with a rotating-mirror camera provided a history of the mass density and electron density across the shock, through the non-equilibrium regime, and into the equilibrium region. The densities were obtained from a shift of fringes associated with the change in refractive index of the gas as the shock propagated through it. The measured time history of the electron production served as a guide to the model finally chosen for the ionization mechanism. The onset of radiation was found to occur rather abruptly toward the end of the non-equilibrium region at a measured level of electron density. To make the experimental results and physical model compatible the relaxation region was separated into three regimes according to the dominant reactions in each. The measured electron densities at the shock front and in the equilibrium region were found to agree with the existing theory. Comparison of the theoretical and experimental equilibration models gave a consistent interpretation to the observed profiles. (Dissertation Abstr.)

38009 CURRENT SHEETS IN A COAXIAL PLASMA GUN. Naraghi, Masud N. Thesis, Cleveland, Case Inst. of Tech., 1964. 93p.

An experimental study of the dynamics and the structure of current sheets in a coaxial plasma gun was made. The gun has an aspect ratio of two, unifirm gas distribution with no preionization, and no auxiliary magnetic field. It is observed that only a small range of pressures will produce a plane symmetrical current sheet. It is found that, although the total current delivered to the gun is time-varying, the sheet conducts a constant current for a relatively long period. A modified snow plow model gives an adequate explanation of the stabilized velocity. Comparison to a shock model and a free-particle model is also given. A novel method of electron temperature measurement by using the resistivity of the sheet is utilized. (Dissertation Abstr.)

38010 COLLISIONAL RELAXATION IN A PLASMA. Johnson, Kurt Philip. Thesis, Evanston, Ill., Northwestern Univ., 1964. 160p.

The Fokker-Planck equation for a plasma is solved by means of an expansion of the velocity distribution function in spherical harmonics in velocity space, using the Rosenbluth potentials. The results are given as equations of motion for the speed-dependent expansion coefficients, for coefficients up to the second-order. A perspective on the solution is obtained by surveying the interrelations between various regimes of plasma and describing some of the analytical techniques applied to these regimes. Original results are presented on relativistic magnetohydrodynamics for the case of a very strong magnetic field where particle collisions are negligible. Derivations of the Fokker-Planck equation are discussed, and a survey of previous work with the Fokker-Planck equation is given to demonstrate its place within the general spherical harmonics expansion treatment. The effect of collisions of electrons with ions on the electron distribution function is described by the Lorentz gas approximation; collisions of ions with electrons are considered to have no effect on the ion distribution function. An approximate treatment of the effect of like-particle collisions is discussed, based on neglecting the anisotropic parts of the Rosenbluth potentials and assuming that particles collide only with slower particles (a high velocity approximation). The resulting collision frequency, as applied to a calculation of the electrical conductivity, gives close agreement with the result obtained numerically by Spitzer from identical equations without these approximations. (Dissertation Abstr.)

38011 A METHOD OF OBTAINING EXACT SOLUTIONS OF THE BOLTZMANN-VLASOV EQUATIONS. Seitz, Robert North. Thesis, Cleveland, Case Inst. of Tech., 1964. 210p.

This thesis presents a "constant-of-the-motion" method of obtaining a large class of exact, nonlinear solutions of the Boltzmann-Vlasov equations for collisionless plasmas. Planar, cylindrical, and spherical steady-state problems are worked out in some detail. Self-consistent electrostatic and externally imposed magnetostatic fields are considered, including some numerical calculations of the Coulomb potential problems. Numerical results are given for the planar plasma converter potential and for the neutralization of planar and cylindrical ion beams. It is also shown that under certain conditions, singularities occur in the phase space flow of the particles giving rise to a functional limit condition on the momentum integrals. The D'Alembert equations then become functional integro-differential equations. Since the functional limit condition occurs quite commonly, previous treatments of the above problems would appear to be incomplete. (Dissertation Abstr.)

38012 ELECTRIC DISCHARGE WITH ELECTRONS OSCILLATING IN MAGNETIC FIELD AT HYDROGEN PRESSURE OF 10^{-2} TO 10^{-4} mm Hg. Morozova, I. G. p.76-87 of "Fizicheskaya Elektronika. Vypusk 2." Moscow, Atomizdat, 1965. (In Russian)

Preliminary studies of the discharge with electrons oscillating in a magnetic field at gas pressures of 10^{-2} to 10^{-4} mm Hg indicate that a magnetic field is essential for continuing the discharge even at these relatively high pres-

sures. The gas pressure has considerable effect on the discharge, with the current sharply increasing at 4.5 to 10×10^{-3} mm Hg for given magnetic induction (B) values and becoming a maximum at 3×10^{-2} mm Hg. At 10^{-4} mm Hg, it is too low for use in ionization chambers of high-current sources. The volt-ampere characteristics of the discharge show that it is normal at pressures below 3×10^{-4} mm Hg and abnormal at higher pressures, with transition observed in the neighborhood of this value. Only fields of low B values affected the shape of the discharge. With increasing B values the luminous column became thicker and then diffuse. At maximum beam currents from the ion source, a thin pinch was observed along the axis of the discharge. At low B values the discharge current varied considerably. The pressure decreased after sparking of the discharge down to 40 mamp, and at high currents began to increase spontaneously, apparently because of release of gas from the electrodes. At relatively high pressures (10^{-2} to 10^{-4} mm Hg), the nature of the discharge from large-volume charges differed considerably from those described earlier. The appearance of the discontinuities at low B values and hysteresis or coupling-hysteresis effects cannot be explained by existing theories. (TTT)

Shielding

Refer also to abstract 36193.

38013 (LA-DC-7139) NEUTRONIC ISOLATION CHARACTERISTICS OF CONCRETE, LEAD, WOOD, POLYETHYLENE AND BERYLLIUM. McCreless, Thomas C. Jr. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). 1965. Contract W-7405-eng-36. 53p. Dep. mn; CFSTI, $3.00 cy, $0.50 mn.

Thesis submitted to Univ. of Maryland, College Park.

Critical approach experiments were conducted to determine the neutron isolating effectiveness of concrete, lead, wood, polyethylene, and beryllium. The Los Alamos Comet assembly machine was used to determine the change in critical thickness of a reference slab of enriched (93.2 wt % ^{235}U) uranium with and without an additional enriched uranium slab beyond an isolator eight inches thick. This change in critical thickness is a measure of the neutron interaction between the uranium units. The isolating abilities of slabs of the selected material eight inches thick are compared to the ability provided by an eight-inch air space. Numerical values for relative isolating ability are obtained for a particular fraction of critical thickness, F, of the additional uranium slab placed beyond the isolator. For F = 0.675, the relative isolating abilities are: polyethylene, 99.6%; lead, 82%; beryllium, 78.7%; concrete, 74%; and plywood, 45.3%. The study provides several other useful results; namely, effectiveness of these materials as reflectors, a tabulation of reflector saving, and the critical thicknesses of infinite slabs of enriched uranium reflected on one side by eight inches of the isolator and with and without a one-half inch thick steel diaphragm. These thicknesses were determined by electronic computer calculations, using the transport theory code and S_4 approximation. (auth)

38014 (N64-29363) COMPUTER CODES FOR THE EVALUATION OF SPACE RADIATION HAZARDS. VOLUME 1. Wilkinson, Maurice C. (Boeing Co., Seattle, Wash. Aero-Space Div.). [1963]. Contract NAS9-1393. 152p. (NASA-CR-58292). CFSTI, $11.50 cy.

The computer codes developed for the evaluation of the absorbed dose in an astronaut's body are discussed. The Apollo vehicle is analyzed by these codes, and the absorbed dose at three body points is found for two lunar trajectories. In addition, the absorbed dose resulting from a solar flare is calculated. These dose results indicate that the geomagnetically trapped radiation does not constitute a significant hazard for either of the two trajectories considered. The solar flare considered results in absorbed doses ranging from 89 rads at the blood forming organ to 1,517 rads at the skin. Additional shielding will be required if a flare of this type is not to produce significant damage. (auth)

38015 (N64-29365) COMPUTER CODES FOR THE EVALUATION OF SPACE RADIATION HAZARDS. VOLUME 3. APOLLO SECTOR ANALYSIS. Ferguson, Dale R. (Boeing Co., Seattle, Wash. Aero-Space Div.). [1962]. Contract NAS9-1393. 27p. (NASA-CR-58294). CFSTI, $2.60 cy.

In order to determine if additional shielding against space radiation is necessary in certain areas of a spacecraft, a detailed sector analysis is required. The spacecraft's inherent radiation shielding for each sector, the body tissue thickness in each sector, and the fractional solid angle for each sector are inputs for computer programs that calculate the dose at a specified body point. Three body points were used, and the average tissue thickness for each solid angle was determined. (auth)

38016 (N64-29368) COMPUTER CODES FOR THE EVALUATION OF SPACE RADIATION HAZARDS. VOLUME 6. ELECTRON TRANSMISSION. Hawkins, Charles T. (Boeing Co., Seattle, Wash. Aero-Space Div.). [1963]. Contract NAS9-1393. 28p. (NASA-CR-58297; D-2-90418-6). CFSTI, $2.60 cy.

The purpose of this program is to compute the space radiation dose caused by electrons being transmitted through a radiation shield. Required inputs for the program are electron flux to dose conversion table, energy spectrum being used, atomic number of shield material, and layer thickness for each solid angle for each sector. The program is presently set up to handle only one type of material at a time. Dose may be calculated at any point inside a vehicle. (auth)

38017 (NP-15094) MONTE CARLO CALCULATION OF NEUTRON STREAMING THROUGH TWO-LEGGED-DUCT ENTRANCEWAYS. Gardner, Leonard B.; Mettler, Alan J. (Naval Civil Engineering Lab., Port Hueneme, Calif.). June 1965. 95p. (R-379)

Several techniques for calculating dose rates in the study of shelter entranceways are reported. Calculations were verified by experiments. These calculations also determine neutron energy spectra, a parameter that is difficult to measure and which is very useful in gaining insight into the design of protective structures. Both the neutron flux spectra and dose rates are calculated for various positions along the centerline of a two-legged duct. Calculations were performed utilizing the ADONIS computer code which solves the Neumann approximation to the transport equation by Monte Carlo techniques. These Monte Carlo calculations were compared to second-leg calculations utilizing a semi-empirical albedo formula, and were also compared to experimental measurements made with a tissue equivalent dosimeter. Included is a discussion of UNIGEOM, a generalized computer program for ADONIS geometry, designed to be run on the IBM 7094. (auth)

38018 SECONDARY NEUTRON FLUXES PRODUCED IN SHIELDING BY 660-Mev PROTONS. Kon'shin, V. A.; Matusevich, E. S.; Prokhorov, S. S. At. Energ. (USSR), 18: 573-8(June 1965).

A set of threshold and resonance indexes were used for measuring the spatial and energy distribution of secondary neutrons in graphite and nickel blocks. The energy distribution of the secondary neutrons at energy range from 2.5×10^{-6} to 6.6×10^{2} Mev is represented by seven groups. The magnitude of the dose behind a nickel or graphite shielding was determined as a function of the shielding thickness. (R.V.J.)

38019 THE DOSAGE OF A MONODIRECTED SOURCE OF γ QUANTA NEAR THE EARTH-AIR BOUNDARY. Bublik, Yu. I.; Ermakov, S. M.; Efimenko, B. A.; Zolotukhin, V. G.; Petrov, E. E. At. Energ. (USSR), 18: 628-9 (June 1965).

The statistical accuracy of γ dosage near the earth-air boundary calculated by Monte Carlo method was within 6 to 8%. It was assumed that the earth and air are two semi-infinite media separated by a boundary. The earth composition of SiO_2(2.0×10^3 kg/m^3 density) and air 21 wt % oxygen and 79 wt % nitrogen (1.29 kg/m^3 density). Diagrams of the dosage as a function of the orientation angle of a

primary ray E_0 = 1.25 Mev are given as well as the dosage as a function of the φ angle for various initial γ-quantum energies. (R.V.J.)

38020 THE FINE ADJUSTMENT OF THE NEUTRON PENETRATION IN THE NRN METHOD. Aalto, E.; Fraeki, R.; Malen, K. (Aktiebolaget Atomenergi, Stockholm). Nucl. Sci. Eng., 22: 443-50(1965).

Recommended values were experimentally obtained for the angle (defined by its cosine μ_0 in center-of-mass system) that determines the boundary between "removal" and "nonremoval" collisions and regulates the deep penetration of neutrons in the NRN method. Measured attenuations in three different, most common, shield materials (water, magnetite, and ordinary concrete) give $\mu_0 = 0.6\ (\pm 0.1)$ for elements with A > 1. For hydrogen, $\mu_0 = 0.45$ is recommended. The results indicate, besides, that the neutron flux predictions are not overly sensitive to the changes in the removal source, caused by varying μ_0. The usual smoothing effect of the diffusion is material dependent, and the strength of the coupling between removal and diffusion parts is seen to decrease when going from water to magnetite and ordinary concrete. (auth)

38021 CALCULATION AND MEASUREMENT OF THE FAST-NEUTRON DIFFERENTIAL DOSE ALBEDO FOR CONCRETE. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 22: 455-62 (1965).

Monte Carlo calculations were carried out in great detail on the reflection properties of concrete for fast neutrons. The results for the differential angular dose albedo for various incident-beam conditions are presented, and some of the other distributions calculated are mentioned. A formula is offered to represent the calculated differential angular dose albedo to better than 10% for about 95% of the values obtained, and which can be used to extend the results to the entire hemispherical range for both incident and reflected neutron velocity vectors. A comparison of the fast-neutron angular dose albedo calculations weighted by an incident spectrum previously measured at the Tower Shielding Facility with the results of a series of dose albedo measurements performed there shows a root mean square deviation from 147 combinations of incident and reflected angle of 3.1%, with the largest single deviation being 9%. This excellent agreement shows that existing cross sections are adequate to calculate differential albedos to a high precision. (auth)

38022 MEASUREMENT AND CALCULATION OF ENERGY DEPOSITION DUE TO CAPTURE GAMMA RAYS INSIDE ANNULI OF CADMIUM, SILVER, AND STAINLESS STEEL. Boyd, A. W.; Connor, H. W. J.; Kushneriuk, S. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Sci. Eng., 22: 494-5(1965).

The energy deposition rates for capture gamma rays in graphite inside tubes of cadmium, silver, and stainless steel were measured using a graphite-CO_2 ion chamber. The measurements were made in the air gap between the inner and outer graphite reflectors of the NRX reactor. The energy deposition rates were also calculated; good agreement was obtained with the measured values. (D.C.W.)

38023 A GAMMA RAY TRANSPORT PROBLEM. Bahr, Gustave Karl. Thesis, Cincinnati, Univ. of Cincinnati, 1964. 139p.

A general digital computer method for simulating (Monte Carlo) gamma-ray transport in the energy range 10 kev - 1.5 Mev was developed. The technique employs a photon library and auxiliary programs that can evaluate transport problems for various source and boundary configurations including inhomogeneities. The system was then utilized to study the plane parallel inhomogeneous slab case using calcium and carbon as inhomogeneities in water. Under the influence of a parallel 1.7-Mev gamma source two distinct peaks were observed in the energy ranges 211-234 and 46.8-70 kev in the backscatter flux. The former can be shown to be a consequence of first Compton backscatter, while the latter is the result of degraded multiple scattered photons. A third faint peak was observed at approximately 10 cm depth both with and without a calcium inhomogeneity in water; it was in the energy range 164-187 kev. In the case of the calcium inhomogeneity, the energy absorbed in a 2-cm thick zone at the upper surface of the calcium essentially remained unchanged as compared to water alone; on the average, the energy absorbed in the calcium inhomogeneity increased by about 46% relative to water. For the same calculation performed in the zone below the lower surface of the calcium slab, the energy absorbed relative to water was reduced by 4%. Similar calculations in the case of carbon revealed an insignificant change in the energy degraded at the upper surface; however, the average energy absorbed in the carbon slab increased by about 65% relative to water, while the energy degraded at the lower surface relative to water reduced by about 7%. Further calculations indicated that in water the photoelectric effect has little influence in transmitting energy to the medium. (Dissertation Abstr.)

Solid State Physics

See also CHEMISTRY — Inorganic and Physical Chemistry
METALS, CERAMICS, AND OTHER MATERIALS — Properties and Structure

Refer also to abstracts 36817, 37757, 37938, and 37977.

38024 (BNL-8322) ELASTIC IMAGE CORRECTIONS FOR DOUBLE-FORCE DISPLACEMENT FIELDS. Townsend, John R. (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The elastic effects of a free surface are found for double-force defects distributed throughout elastically isotropic spheres and cylinders. This permits separation of the rapidly fluctuating displacement fields found near the defects from the slowly varying image displacements. The spherically asymmetric displacement fields produce zero average volume dilatations both for the cylinder and the sphere. (auth)

38025 (COO-1198-266) MÖSSBAUER EFFECT AT HIGH PRESSURES. Frauenfelder, H.; Ingalls, R. (Illinois Univ., Urbana. Dept. of Physics and Illinois Univ., Urbana. Materials Research Lab.). [1964]. Contracts Nonr-1834 (05) and AT(11-1)-1198. 24p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Uses of the Mössbauer effect for studies under very high pressure are reviewed. Theories of the pressure variation of the recoilless fraction, the electric field gradient, the isomer shift, and the internal magnetic field of solids are summarized. An experimental set-up to study the Mössbauer effect under pressure is described, including design of the pressure cell and Mossbauer source, the pressure calibration, and some constraints on possible experiments due to the cell configuration. Some recent results are presented on the isomer shift, quadrupole splitting, and internal magnetic field of ^{57}Fe. (M.J.T.)

38026 (INP-407/PL) TEMPERATURE DEPENDENCE OF THE EFFECTIVE MAGNETIC FIELDS IN SPINEL TYPE FERRITES STUDIED BY THE MOESSBAUER EFFECT. Hrynkiewicz, A. Z.; Kulgawczuk, D. S.; Tomala, K. (Institute of Nuclear Physics, Krakow (Poland)). Apr. 1965. 6p. Dep.

The effective magnetic fields for Fe^{3+} in the ferrites $NiFe_2O_4$, $CoFe_2O_4$, $MnFe_2O_4$, and $MgFe_2O_4$ were measured. The average magnetic fields for the two sublattices at 0°K obtained by extrapolation are, in the limit of experimental error, the same for the investigated compounds and amount to about 530 kOe. The temperature dependence of H_{eff} for $NiFe_2O_4$ is in good agreement with the Brillouin curve for average molecular field. (auth)

38027 (ORNL-3841) SOLID STATE DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 31,

1965. (Oak Ridge National Lab., Tenn.). July 1965. Contract W-7405-eng-26. 101p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Solid-state research is reviewed in theoretical areas as well as in the fields of crystal physics, nonmetals and metals, and radiation metallurgy. (T.F.H.)

38028 (ORNL-P-1396) A NOTE ON THE DETERMINATION OF A METASTABLE MISCIBILITY GAP FROM INTEGRATED SMALL-ANGLE X-RAY SCATTERING DATA. Hendricks, R. W.; Borie, B. S. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 27p. (CONF-650629-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From Conference on Small-Angle X-Ray Scattering, Syracuse, N. Y.

The Gerold and Cowley theories of integrated small-angle x-ray scattering data appear, at first sight, to be in disagreement regarding their relation to the phase boundaries of the metastable miscibility gap which is believed to describe the formation of Guinier-Preston zones in quenched Al–Ag, Al–Zn, and NaCl–AgCl solid solutions. A new derivation, based on the two-phase model of the zones, shows that the Crowley description of that portion of the total intensity which is sensitive to the local atomic arrangements consists of four physically distinguishable parts, three of which are not observable in most small-angle scattering experiments. On eliminating these terms, the remaining intensity is related to the composition of the metastable miscibility gap, but the relationship differs somewhat from the one derived by Gerold. The differences between the two theories are examined in detail, and the metastable miscibility gap for quenched Al–Ag alloys is recomputed. (auth)

38029 (SC-RR-65-307) SOLVING THE SECOND BOUNDARY VALUE PROBLEM OF ELASTICITY. Hultgren, Ronald O. (Sandia Lab., Albuquerque, N. Mex.). July 1965. Contract AT(29-1)-789. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

When the surface displacements of an elastic plane body are known, the stress distributions and the displacement distribution throughout the body can be determined by the methods presented. Applicable cross sections are those which can be conformally mapped to the half plane. (auth)

38030 (ZFK-WF-27) DIE ENERGIEUBERTRAGUNG BEWEGTER ATOME IN EINEM KRISTALLGITTER DURCH FOKUSSIERENDE STOSSE. (The Energy Transfer of Moving Atoms in a Crystal Lattice Through Focusing Impact). Oskar Hauser (Deutsche Akademie der Wissenschaften zu Berlin (East Germany) and Zentralinstitut fur Kernphysik, Rossendorf bei Dresden (East Germany)). Jan. 1965. 19p. Dep.(mn).

A bibliographic review is given of the theories that explain the energy transfer of moving atoms in a crystal lattice through focusing impact. Some of the most important experiments based on this theory are summarized. 28 references. (J.S.R.)

38031 DISCONTINUOUS OCCURRENCE OF LOCALIZED MOMENTS IN METALS. Jaccarino, V.; Walker, L. R. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 15: 258-9(Aug. 9, 1965).

Evidence is presented which suggests that the magnetization process for an impurity ion in a metallic host system may be essentially a discontinuous one, the moment being either zero or some maximum value, rather than a continuous change. The apparent continuous change in average moment is then associated with the probability that individual impurity ions have magnetized. This probability is further associated with that of certain neighboring configurations of ions in the alloy system. Compelling evidence for the idea of discontinuous magnetization is found in various metal systems and no known experimental data exist which are in conflict with the discreteness concept. (J.F.P.)

38032 DIFFUSION OF X RAYS BY THERMAL AGITATION IN THE CRYSTALLINE MEDIUM. Leval, Jean (College de France, Paris). Z. Krist., 120: 95-101(July 1964). (In French)

A theory of diffusion of x rays by thermal effects in crystals is presented. Such selective reflections of progressive waves are extremely weak but quite numerous. Since their wavelengths are distributed uniformly in all directions, they redirect x rays in every direction. They change the frequency of the x rays by the Doppler effect; the change in frequency is quantized, by the usual x rays, and the relative differences are very small, of the order of 10^{-5}. The partial diffusing power varies as a function of the absolute temperature Θ: $\Theta^n e^{-A\Theta}$, where A is a constant. Thus it increases as the temperature rises from absolute zero, passes through a maximum, then diminishes. The series expressing the diffusing power converges at all temperatures; at high temperatures, convergence does not become rapid until the third or fourth term. At ordinary temperatures, the diffusing power is produced by six acoustical oscillations. From these the velocity of the waves may be calculated and then determine the elasticity of the crystalline medium. (BBB)

38033 MEASUREMENT OF ARGON DIFFUSION IN KCl AND KBr (RARE GAS DIFFUSION IN SOLIDS. 22). Richter, A. H. K.; Zimen, K. E. (Hahn-Meitner-Institut fur Kernforschung, Berlin). Z. Naturforsch., 20a: 666-72 (May 1965). (In German)

The diffusion of radioactive Ar was measured in pure and doped single crystals of KCl and KBr as well as in pressed-powered tablets of KCl at 300 to 700°C. Activation energies were found to be 2.4 ev (55 kcal/mol) for KCl and 1.5 ev (36 kcal/mol) for KBr below 400°C, and 0.6 ev (14 kcal/mol) for KCl and 0.4 ev (8 kcal/mol) for KBr above 400°C. Below 400°C the gas output was slowed down in the first 40 to 80 minutes. For $SrCl_2$ and K_2S doped KCl crystals, the diffusion behavior did not differ from the KCl single crystals. The porosity of the KCl tablets was found to affect the rare gas output. (tr-auth)

38034 DIFFUSION OF NON-GASEOUS FISSION PRODUCTS IN UO_2 SINGLE CRYSTALS. II. Oi, Noboru; J Takagi, Jinzaburo (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan and NAIG Nuclear Research Lab., [Japan]). Z. Naturforsch., 20a: 673-5(May 1965).

The release of short-lived non-gaseous fission products from UO_2 single crystals was studied in the temperature range of 1400 to 2500°C by means of post-irradiation annealing. The release of the fission products studied appears to follow the kinetics of a diffusion process. Analysis of the data obtained gives the following diffusion constant, $D_{Mo} = 3.9 \times 10^{-4} \exp(-54{,}000/RT)$, $D_I = 1.5 \times 10^{-3} \exp(-59{,}000/RT)$, $D_{Te} = 6.6 \times 10^{-3} \exp(-70{,}000/RT)$, D_{La} (tentative) $= 2.2 \times 10^{-6} \exp(-35{,}000/RT)$ where the dimensions of D and RT are cm^2/sec and cal/mol, respectively. (auth)

38035 SOME PROPERTIES OF A FERROMAGNETIC CRYSTAL CONTAINING A MAGNETIC IMPURITY ATOM. Izyumov, Yu. A.; Medvedev, M. V. (Inst. of Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 48: 1723-31(June 1965). (In Russian)

Some effects due to the existence of local magnetic oscillations in a ferromagnetic crystal containing impurities at low temperatures are considered. It is shown that if one of the local levels lies near the bottom of the spin-wave band, an anomaly in the temperature dependence of the spontaneous magnetization should be observed, namely, it should decrease more rapidly than $T^{\frac{3}{2}}$ for an ideal crystal even if the impurity concentration does not exceed several percent. Ferromagnetic resonance in such a crystal in an homogeneous r-f field is also considered. It is shown that for various values of the g-factors for the matrix and impurity atoms, the r-f field can excite only oscillations of the s-type. Only the usual type of ferromagnetic resonance with excitation of uniform spin precession should be observed for equal g-factors. (auth)

38036 SOLID STATE PHYSICS. ADVANCES IN RESEARCH AND APPLICATIONS. VOLUME 17. Seitz, Frederick; Turnbull, David (eds.). New York, Academic Press, 1965. 393p. $14.00.

The effects of high pressure on the electron structure of

solids are surveyed first, and the results of electron spin resonance experiments on magnetic ions in various oxide crystals are reviewed. The application of ultrasonic techniques to studies of the properties of semiconductors is then described, and the quantum theory of the galvanomagnetic effect in very strong magnetic fields is reviewed. (D.C.W.)

38037 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON MAGNETISM, NOTTINGHAM, SEPTEMBER 1964. London, The Institute of Physics and The Physical Society, [1965]. 892p. 8 pounds, 8 shillings. (CONF-788).

Eight hundred seventy-five papers are included; separate abstracts were prepared for 40. Three papers were previously abstracted for NSA; see 18: 11150, 18: 26038, and 19: 2269. (L.B.S.)

For abstracts of individual papers see: 37757, 38038, 38039, 38040, 38041, 38042, 38043, 38044, 38045, 38046, 38047, 38048, 38049, 38050, 38051, 38052, 38053, 38054, 38055, 38056, 38057, 38058, 38059, 38060, 38061, 38062, 38063, 38064, 38065, 38066, 38067, 38068, 38069, 38070, 38071, 38072, 38073, 38074, 38075, and 38076.

38038 CRITICAL MAGNETIC SCATTERING OF NEUTRONS IN MnF_2. Okazaki, A.; Stevenson, R. W. H.; Turberfield, K. C. (Atomic Energy Research Establishment, Harwell, Berks, Eng. and Aberdeen Univ., Scotland). pp 92-3 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Observations of critical magnetic scattering of neutrons in a single crystal of MnF_2 about the 001 and 100 reciprocal lattice points are reported, which demonstrated directly the presence of the anisotropy term in the transverse spatial spin-correlation function. (L.B.S.)

38039 MAGNETIC SCATTERING OF NEUTRONS IN CHROMIUM. Moeller, H. Bjerrum; Blinowski, K.; Mackintosh, A. R.; Brun, T.; Nielsen, P. (Atomenergikommissionen, Risoe, Denmark; Universitet, Copenhagen; and Tekniske Hoejskole, Copenhagen). pp 101-2 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The magnetic scattering of neutrons from chromium was studied in the vicinity of the Néel temperature. The results of measurements on the magnetic Bragg reflection below the Néel temperature showed that the amplitude of the transverse magnetic wave along [100] is much greater than that along [010]. The results for critical magnetic scattering above the Néel temperature are shown, together with the best fits of six superimposed Lorentzian peaks. A good fit was possible only for transverse polarization of the spin density waves. From comparison of theoretical and experimental curves, the temperature dependence of k_1, which describes the decay in space of the pair correlation, was determined. (L.B.S.)

38040 NEUTRON DIFFRACTION STUDIES OF Pd-RICH FERROMAGNETIC ALLOYS. Low, G. G. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). pp 133-4 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Application of neutron diffraction to the study of the electronic structure of disordered ferromagnetic alloys was made in measurements on five PdFe samples containing 4, 2, 1, ½, and ¼ at. % of Fe. A plot of the distribution of the magnetic moment density in the Pd matrix surrounding an Fe atom is shown, which was derived from the neutron scattering data for the alloy containing ¼ at. % Fe. The moment on a Pd atom, which is a nearest neighbor to an Fe site, was found to be 0.06 μ_B. The large total moment associated with the polarization around each Fe atom is attributed to the long range nature of the distribution. (L.B.S.)

38041 VARIATION OF ^{57}Fe ISOMER SHIFT WITH ATOMIC SIZE IN LAVES PHASES AND ASSOCIATED QUADRUPOLE AND MAGNETIC HYPERFINE FIELDS. Nevitt, M. V.; Kimball, C. W.; Preston, R. S. (Argonne National Lab., Ill.). pp 137-40 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

It was previously shown by a study of the isomer shift that the excitation energy of the Mössbauer level in ^{57}Fe decreases with increasing hydrostatic pressure. This effect was attributed almost entirely to the increase in electronic charge density at the nucleus as a result of the decrease in the size of the iron atom. Laves phases of composition XFe_2 provide another means of varying the atomic volume of iron. The volume, as determined from interatomic distances, varies with the size of the partner atom. Mössbauer measurements were made of the magnetic hyperfine field, the quadrupole hyperfine field, and the variation of the isomer shift for ^{57}Fe in a series of XFe_2 Laves phases over a range of temperatures. A systematic variation of shift was found with effective size of the iron atom; which suggests that an increased electronic charge density at the nucleus accompanies the decreasing volume of the iron atom. The study also revealed new information on quadrupolar splitting and magnetic hyperfine fields, which is discussed. (auth)

38042 MOESSBAUER EFFECT IN INVAR ALLOYS, Nakamura, Y.; Shiga, M.; Endoh, Y. (Kyoto Univ.). pp 144-5 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Internal magnetic fields at iron nuclei in FeNi and FePt alloys were measured by means of the Mössbauer effect in order to study the origin of invar behavior. Paramagnetic absorption lines were observed together with ferromagnetic lines below the Curie temperature, which strongly indicate the coexistence of paramagnetic and ferromagnetic regions. (L.B.S.)

38043 LOCALIZED MOMENT FORMATION IN Ti, Zr AND Hf-BASED ALLOYS. Cape, J. A.; Hake, R. R. (Atomics International, Canoga Park, Calif.). pp 151-3 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The occurrence of localized magnetic states in the transition elements, Ti, Zr, and Hf, was studied, which consisted of a search for resistive anomalies arising from very dilute concentrations of Cr, Mn, Fe and Co, and the f shell ferromagnetic Gd. An attempt was made to correlate the transport measurements with a local moment as determined by the measurement of the magnetic susceptibility. It was observed that the iron-group impurities give rise to localized moments; the degree of localization increases on going from Ti to Zr to Hf, possibly owing to a decreasing density of states in the host metals. The composite results derived from the susceptibility, resistivity, and magnetoresistivity data are tabulated and discussed. (L.B.S.)

38044 ANTIFERROMAGNETISM AND SUPERCONDUCTIVITY IN THE CHROMIUM–RHENIUM SYSTEM. Bender, D.; Muheim, J.; Mueller, J. (Eidgenoessische Technische Hochschule, Zurich and Universite, Geneva). pp 162-4 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

An important change in the electronic structure of chromium rich alloys with rhenium was found to occur within the range of the body-centred cubic solid solutions. With increasing rhenium concentration an antiferromagnetic region with first rising, then decreasing, Néel temperatures is followed by a substantial increase in the density of states and the appearance of superconductivity. In the antiferromagnetic region, the variation of the observed properties, including the electronic specific heat, the paramagnetic susceptibility and the electrical resistivity, can be accounted for on the basis of the theory of spin-density waves developed by Overhauser. The anomalies which occur at the Néel temperature of chromium are greatly

increased in magnitude by alloying with rhenium, suggesting the presence of large amplitude spin-density waves as a result of the close contact of the electron Fermi surface, displaced by the polarization wave vector, and the hole Fermi surface. (auth)

38045 MAGNETIC SUSCEPTIBILITY OF SCANDIUM AND SCANDIUM–TITANIUM ALLOYS. Anderson, R. A.; Gardner, W. E.; Penfold, J. (Atomic Energy Research Establishment, Harwell, Berks, Eng.). pp 186-7 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Measurements were made of the susceptibility of various sources of scandium metal by a Faraday method, using a Sartorius balance. The results indicated that the variation of susceptibility is linear from 300 to 20°K. Measurements were also made on Sc-Ti alloys (3.5 and 10% Ti), and the results showed that the susceptibility varied linearly with Ti concentration. Using a rigid band model, the results indicated a fall in density of states with the addition of electrons. (L.B.S.)

38046 ELECTRICAL AND MAGNETIC PROPERTIES OF PALLADIUM THORIUM ALLOYS. Bates, L. F.; Unstead, P. B. (Univ. of Nottingham, Eng.). pp 188-91 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Magnetic susceptibility and electrical resistivity measurements were made on alloys of Pd and Th, the susceptibility measurements in the temperature range 90 to 1200°K, and resistivity measurements in the range 300 to 1000°K. The lattice parameter a_0 has been determined by x-ray methods for specimens up to 20% Th in Pd; above this composition the system appears to be two-phase. The alloys are diamagnetic in compositions between approximately 13 to 40% Th in Pd. The low percentage thorium alloys obey Matthiessen's rule, but in the region of 10% Th marked deviations from this rule occur. An attempt was made to explain the results in terms of a band model and a valency of 4 for thorium. (auth)

38047 POSITRON ANNIHILATION IN FERROMAGNETIC SINGLE CRYSTALS. Mijnarends, P. E. (Institut for Atomenergi, Kjeller, Norway). pp 230-2 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The results of experiments on the annihilation of polarized positrons in ferromagnetic metals are reported. Such measurements can yield information concerning the spin density distribution in ferromagnets. The first experiments of this kind were done by Hanna and Preston in 1958, using a set-up with a cylindrical symmetry. Recently new measurements with a parallel slit geometry and improved accuracy were reported by Berko and Zuckerman and by Mijnarends and Hambro in 1964. In addition to the results on iron previously published similar measurements on face-centred cubic $Co_{0.91}Fe_{0.09}$ are presented and the problem of the interpretation of these measurements is re-examined. (auth)

38048 A STUDY OF CONDUCTION ELECTRON POLARIZATION IN FERROMAGNETIC RARE EARTH METALS USING PERTURBATION OF γ–γ CORRELATIONS. Cohen, S. G.; Kaplan, N.; Ofer, S. (Hebrew Univ., Jerusalem). pp 233-7 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The effective magnetic fields H_{eff} at ^{175}Lu and ^{177}Hf nuclei within diamagnetic ions, situated as dilute impurities in ferromagnetic rare earth metals, were determined using the technique of measuring the perturbation of the integral angular correlation of γ–γ cascades emitted from these nuclei, as a function of temperature, both in the presence of an external magnetic field and without an external field. It is concluded from the results that the effective field in all cases is negative, i.e., opposite to the magnetization, that the magnitude of H_{eff} is proportional to the magnetization, at least in the case of Gd host metal, and that for ^{177}Hf the magnitude of H_{eff} follows very roughly the magnitude of the spin S of the magnetic host. Assuming that the main contribution to H_{eff} is due to polarized conduction electrons, it can be shown that within the Kasuya-Yosida model, the effective s-f exchange interaction, $\mathcal{J}_{s-f}$, is negative and of the order of -0.1 ev. (auth)

38049 THE MAGNETIZATION OF FERROMAGNETIC CUBIC LAVES PHASE COMPOUNDS OF RARE EARTHS WITH TRANSITION ELEMENTS. Crangle, J.; Ross, J. W. (Univ. of Sheffield, Eng.). pp 240-3 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The magnetization of cubic Laves phase compounds of type RT_2, where R is Ce, Pr, Sm, Gd, Tb, Dy, Ho, or Er and T is Co, Rh, Pt, Fe, or Ni was measured between 2°K and the respective Curie points, which sometimes range up to 800°K. The maximum magnetic field strength used was 18 kilo-oersteds. It is concluded that in all cases except the Gd compounds, crystal field effects are influential in reducing the magnetic moment associated with the rare earth elements. In the RFe_2 and RCo_2 compounds magnetic moments appear to reside on the T atoms, but not apparently where T is other transition elements. In RFe_2 and RCo_2 the Fe and Co moments align themselves so that they always oppose the direction of the spin part of the rare earth moment. (auth)

38050 THEORY OF RARE EARTH METALS. Kasuya, T. (Tokyo Univ.). pp 247-9 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

A model for the band structure in rare earth metals is proposed on the nearly free electron picture. Based on this model, various properties of rare earth metals are explained self-consistently, both qualitatively and quantitatively. (auth)

38051 MAGNETOSTRICTION IN HEAVY RARE EARTH METALS. Tsuya, N.; Clark, A. E.; Bozorth, R. M. (Naval Ordnance Lab., White Oak, Silver Spring, Md. and Univ. of Maryland, College Park). pp 250-4 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The magnetostrictive strains in the ferromagnetic rare earth metals have been reported to be extraordinarily large ($>10^{-3}$) at low temperatures. To examine the origin of these strains, the effects of two mechanisms are considered: the distortion of the crystal field due to the nearest neighbor positive ions, and the field arising from the strained charge distribution of the conduction electrons. The predicted signs for the shear magnetostrictions in single crystals of dysprosium and holmium are positive, in agreement with experiment. (The magnitude of these coefficients depends upon the deformability of the conduction electrons and the screening of the neighboring positive cores.) According to these mechanisms, each of the four lowest order magnetoelastic coupling coefficients are related as follows, taking Dy as +100: Gd(0), Tb(+104), Ho(+38), Er(−37), Tm(−88), and hexagonal Yb(−84). The sign change between Ho and Er was confirmed by measurements of the magnetostriction of single crystals of Er. The reported magnetostrictions in Ho and Gd, which are about $\frac{1}{3}$ and $\frac{1}{100}$ respectively as large as those in Dy, are also in agreement with this finding. (auth)

38052 STUDY OF THE MAGNETIC PROPERTIES OF RARE EARTH ELEMENTS UNDER HYDROSTATIC PRESSURE. Bloch, D.; Pauthenet, R. (Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France). pp 255-9 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Variations with pressure of the Curie point θ_f for gadolinium, of the Néel points θ_N for terbium, dysprosium and holmium were measured, as well as the variation of the spontaneous magnetization for gadolinium, terbium and dysprosium at 77°K. In the molecular field approximation, the results lead to the conclusion that at 77°K the satura-

tion moment should vary with pressure. The interpretation of the results is studied from the point of view of the mechanism of indirect exchange by the conduction electrons for the magnetization. The variation of the saturation moment of Gd and Dy is compared with the variation of the conduction electron polarization; for Tb, the pressure induces the electrons to transfer from the 4f shell to the conduction band. (auth)

38053 EFFECT OF HYDROSTATIC PRESSURE ON MAGNETIZATION OF SOME RARE EARTH METALS. Kondorskii, E. I.; Vinokurova, L. I. (Moscow State Univ.). pp 260-2 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The influence of uniform compression up to 5500 kg cm^{-2} on the magnetization of polycrystalline samples of gadolinium, terbium and dysprosium was studied. The measurements were carried out in magnetic fields up to 17 kOe in the temperature range from 77 to 230°K. The value and sign of the pressure coefficient $\sigma_s^{-1}(\Delta\sigma_s/\Delta p)$ in gadolinium are found to be the same as those in iron-group metals. It was found that there are extremal values on the curves of the field dependence of $(\Delta\psi/\psi)p^{-1}$ in dysprosium and terbium in the transition from the antiferromagnetic state to the ferromagnetic state, and change of the sign of $(\Delta\psi/\psi)p^{-1}$ in dysprosium near the Néel temperature are accounted for as being due to the influence of the pressure on the values of the magnetic anisotropy constants. (auth)

38054 CRITICAL POINTS AND MOMENTS OF SOME BINARY RARE EARTH ALLOYS. Bozorth, R. M.; Gambino, R. J. (IBM Watson Research Center, Yorktown Heights, N. Y.). pp 263-5 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Observed values of the Néel points T_N and Curie points T_C of a number of alloys of the heavy rare earths confirm the previous view that T_N is nearly a universal decreasing function of the number of electrons in the 4f shell, and show that T_C, on the contrary, is specifically dependent on the elements alloyed. A particularly important concentration of 4f electrons is 10.5, between Ho and Er, where the Curie points of alloys of these elements rise to 35°K, almost twice that of the elements. At the same average electron concentration a Dy-Tm alloy shows a Curie point below that of either element. Gadolinium alloys with Dy and with Er show that the spiral structure that occurs in the latter elements between T_N and T_C ceases to exist at 4f electron concentrations of 7.9 and 8.8, respectively. (auth)

38055 PECULIARITIES OF THE MAGNETIC PROPERTIES OF GADOLINIUM NEAR THE CURIE POINT. Belov, K. P. (Moscow State Univ.). pp 266-70 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Using the thermodynamical analysis (Belov 1959) of the magnetization curves near the magnetic phase transition, some peculiarities of magnetic behavior of Gd single crystals are revealed. It is shown that the magnetic anisotropy energy is sufficient to influence the spontaneous magnetization near the Curie temperature. This fact results in the effect of anisotropy of the Curie point. The Curie point along the easiest direction (c axis) is slightly higher (~1.5°) than along the hard direction (basal plane). Analysis of the magnetostriction and thermal expansion of a Gd crystal makes it possible to conclude that the shift of the Curie point due to hydrostatic pressure must be an order higher than that in the basal plane, being negative along the c axis and positive in the basal plane. Peculiar temperature dependences of magnetization (measured in weak fields), coercive force, resistance and magnetoresistance, both in the temperature region close to the Curie point itself, and in the sub-transitional region (210-290°K) as well, indicate the complexity of the magnetic phase transition in Gd crystals. The features of the magnetization and the accompanying effects in the region of the Curie point and in the sub-transitional region are very similar to those in Tb and Dy in the region of magnetic transitions ferromagnetism–helical antiferromagnetism–paramagnetism. (auth)

38056 NEUTRON MAGNETIC SCATTERING STUDIES AT THE OAK RIDGE NATIONAL LABORATORY. Koehler, W. C.; Cable, J. W.; Child, H. R.; Moon, R. M.; Wollan, E. O. (Oak Ridge National Lab., Tenn.). pp 271-2 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Experiments were performed on intermetallic compounds, Laves phase compounds, and alloys of rare earths to investigate the nature of the exchange interaction between rare earth atoms, and to study the effects of dilution on the magnetic properties of the heavy rare earth metals. A partial summary of results is presented. (L.B.S.)

38057 INVESTIGATIONS AT THE NUCLEAR CENTRE IN GRENOBLE: THE MAGNETIC STRUCTURES OF $CrHoO_3$, $MnYO_3$, GeM_2O_4 (M = Ni, Co) AND $NdCo_5$. Bertaut, E. F. (CNRS, Grenoble, France and CENG, Grenoble, France); Buisson, G.; Delapalme, A. (and others). pp 275-84 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The magnetic structures of $CrHoO_3$, $MnYO_3$, GeM_2O_4 (M = Ni, Co) and $NdCo_5$ were studied. $CrHoO_3$ shows the same complex magnetic structure at low temperatures as $FeHoO_3$. The Cr atoms order first at 140°K the rare earth at about 12°K. At 4.2°K the Cr spins have an antiferromagnetic G_z component and the rare-earth a ferromagnetic F_x component of $3.4\mu_B$ and an antiferromagnetic C_y component of $7.0\mu_B$. In $MnYO_3$ the ambiguity between models α and β, reported earlier was resolved by single crystal intensity measurements which favor model α. $GeNi_2O_4$ and $GeCo_2O_4$ adopt a rhombohedral type of ordering. The 4 sub-lattices of the octahedral sites B_j (j = 1,2,3,4) split into a b = B_1 lattice and an e = (B_2 + B_3 + B_4) lattice. Both order antiferromagnetically along the ternary axis with a propagation vector k = [½ ½ ½]. The spins of $GeNi_2O_4$ and $GeCo_2O_4$ subtend angles of ½π and ⅓π respectively with the ternary axis. Spin values are S_{Ni} = 1.11 and S_{Co} = 1.7. In $NdCo_5$ (type $CaCu_5$) the maximum magnetization observed in low fields between 225°K and 300°K is correlated with a spin rotation from the a axis at 230°K to the c axis at 290°K as shown by an x-ray study on powder samples oriented and glued in a magnetic field. At 78°K neutron diffraction shows a ferromagnetic arrangement with Co moments of $1.5\mu_B$ and a Nd moment of only $2.15\mu_B$. (auth)

38058 NEUTRON DIFFRACTION BY VORTEX LINES IN SUPERCONDUCTING NIOBIUM. Cribier, D.; Farnoux, B.; Jacrot, B.; Rao, L. Madhav; Vivet, B.; Antonini, M. (Centre d'Etudes Nucleaires, Saclay, France). pp 285-7 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Neutron diffraction is used to prove the existence of vortex lines in superconducting niobium in the mixed state. The existence of a Bragg peak in the angular distribution of scattered neutrons establishes the periodicity of the structure of the magnetic induction within the sample. The measured lattice parameter d is in good agreement with the values deduced from the relation B = ch/2ed² where B is the magnetic induction. (auth)

38059 POLARIZED NEUTRON INVESTIGATION OF THE $CoPt_3$ AND FePd ALLOYS. Antonini, B.; Felcher, G. P.; Mazzone, G.; Menzinger, F.; Paoletti, A. (CNEN, Rome). pp 288-90 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Results of an investigation, by means of the polarized technique, of the magnetic electron distribution in two alloys of elements of the first transition group with 5d and 4d atoms are reported. It was found that both platinum and palladium show an appreciable magnetic moment. Fur-

thermore it was seen that Co and Fe in these alloys do not preserve the same arrangement of magnetic electrons which they have in their pure state. It seems that the Pt form factor deviates strongly from what is expected for a 5d element. (auth)

38060 MAGNETIC STRUCTURES IN THE MnSb–CrSb AND CrTe–CrSb SYSTEMS. Cox, D. E.; Shirane, G.; Takei, W. J. (Brookhaven National Lab., Upton, N. Y. and Westinghouse Research Labs., Pittsburgh). pp 291-4 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

A previous neutron diffraction study of solid solutions of ferromagnetic MnSb with antiferromagnetic CrSb, which have the hexagonal NiAs type of crystal structure, showed that canted magnetic structures were formed over a wide range of composition. Detailed measurements of the temperature and field dependence of magnetic reflections from $Mn_{0.65}Cr_{0.35}Sb$ have now been made, and shown that the ferromagnetic and antiferromagnetic spin components order at different temperatures. A similar study of MnSb confirms the existence of a spin flip at about 520°K indicated by previous magnetic measurements. A number of compositions in the isostructural series between ferromagnetic CrTe and antiferromagnetic CrSb were also examined. The magnetic phase diagram is found to be similar to that of MnSb-CrSb, with canted spin arrangements occurring over a large part of the system. However, a different antiferromagnetic component with orthorhombic symmetry is found at the Te rich end. (auth)

38061 A NEUTRON DIFFRACTION STUDY OF THE INFLUENCE OF TEMPERATURE ON SPIN CONFIGURATION IN SPINEL MnV_2O_4. Plumier, R. (Centre d'Etudes Nucleaires, Saclay, France). pp 295-8 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Neutron diffraction study of MnV_2O_4 at various temperatures shows that the magnetic structure is of the Yafet and Kittel type up to about 52°K. From 52°K up to the Curie point of 56°K, the structure is of the Néel type. The sudden decrease of magnetization in that temperature range suggests that the transition is of the first order. It is then shown that a tetragonal distortion of the cell ($e_{rr} \simeq -3 \times 10^{-3}$) leads to a reduction of the free energy without substantial change of the spin angle. A first result of the distortion is to stabilize Yafet and Kittel coupling towards more complex spin arrangements. The sudden transition observed at 56°K is then connected with the vanishing of the distortion. Comparison between MnV_2O_4 and MgV_2O_4 and CoV_2O_4 is made in respect to the dependence of the exchange integral on distance. (auth)

38062 IMAGE OF THE FERMI SURFACE IN THE MAGNON SPECTRUM OF FACE-CENTRED CUBIC COBALT. Frikkee, E.; Riste, T. (Institutt for Atomenergi, Kjeller, Norway). pp 299-301 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

If the conduction electrons in ferromagnetic metals take part in establishing magnetic order through exchange interactions with the unpaired electrons, Kohn anomalies are expected to show up in the magnon dispersion relation. Inelastic neutron scattering experiments were carried out on the ferromagnetic alloy $Co_{0.91}Fe_{0.09}$ by means of the so called diffraction method. Although this technique does not allow a direct determination of the energy and wave vector of the magnons it offers the possibility of detecting small deviations from their quadratic dispersion relation. Pronounced deviations from the normal neutron-magnon scattering patterns are observed, which cannot be attributed to additional scattering processes. It is concluded that the irregularities are caused by a Kohn anomaly in the magnon spectrum. The location of the anomaly in reciprocal space is determined along three directions, but no attempts were made to deduce the geometry of the Fermi surface. (auth)

38063 ENERGY SPECTRA OF NEUTRONS SCATTERED FROM PARAMAGNETIC MnO. Deniz, K. Usha; Venkataraman, G.; Satyamurthy, N. S.; Dasannacharya, B. A.; Iyengar, P. K. (Atomic Energy Establishment, Trombay, India). pp 322-4 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Scattering of cold neutrons from MnO was studied above the Néel temperature at several scattering angles using a rotating crystal spectrometer. The distributions of scattered neutrons indicate a distinct inelastic component of magnetic origin. The energy transfer corresponding to this inelastic peak is found to be dependent on $Q_0 (=(4\pi/\lambda)\sin\frac{1}{2}\varphi)$ and is a minimum at $Q_0 = 1.21$ Å^{-1} where the maximum of the diffraction pattern due to short range ordering occurs. The second moments of the energy distributions at large angles were used to derive values of the first and second neighbor exchange integrals. The values are $J_1 = 4$°K and $J_2 = 2.5$°K which are in agreement with other reported values. An attempt was made to compare the observed spectrum at large angles with calculations based on Van Vleck's cluster model using the derived exchange integrals. (auth)

38064 PARAMAGNETIC RESONANCE OF Gd^{3+} PAIRS IN $LaCl_3$. Hutchings, M. T.; Wolf, W. P. (Oxford Univ.). pp 342-6 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The paramagnetic resonance spectrum of pairs of Gd^{3+} ions in $LaCl_3$, which is isostructural with the ionic ferromagnetic $GdCl_3$, was investigated. This is a case in which the exchange interactions are relatively small and comparable with the dipolar interactions and it should therefore be possible to determine the exchange constants from the pair line positions alone. Although the spectrum has so far proved too complex to enable all the lines to be identified unambiguously, it has proved possible to make an estimate of the nearest neighbor exchange constant from the characteristic grouping of lines observed when the magnetic field is along the c axis. Subject to some reasonable assumptions, $J_{ex}(n.n) \sim +0.011$ cm^{-1} is found with a maximum error of about 50%, where $H_{ex}(n.n) = +J_{ex}(n.n)\, S^{(1)} \cdot S^{(2)}$. This value is an order of magnitude smaller than that found for concentrated $GdCl_3$. (auth)

38065 ELECTRON SPIN RESONANCE IN GADOLINIUM METAL SINGLE CRYSTALS. Rodbell, D. S.; Moore, T. W. (General Electric Research Lab., Schenectady, N. Y.). pp 427-31 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Gadolinium metal is a system of relative simplicity as far as exchange interactions and ionic states are concerned. The Gd^{3+} ions are most likely exchange coupled via conduction electrons. The present work concerns the measurement of the ferromagnetic resonance behavior of a single crystal from above the Curie point (20°C) to 4.2°K. The resonance absorptions are well defined at all frequencies used and at all temperatures for most crystal orientations. The minimum linewidth observed is about 400 Oe but the line shape and width degrade when the applied field departs from the easy axis. The deduced magnetocrystalline anisotropy energy is described by the standard uniaxial expansion $E_A = K_1 \sin^2\theta + K_2 \sin^4\theta + \ldots$, about the hexagonal axis. The anisotropy constants derived from the resonance data agree reasonably well with those measured by Graham using static torque methods. The samples used in these experiments are from the same source. The demagnetization fields at the surface of the coin-shaped sample are measured directly from the shift in the resonance field of a small chip of the free radical DPPH in intimate contact with the sample surface. The corresponding demagnetization factors lie between that calculated by Schlömann for a uniformly magnetized right cylinder (an accurate description of our sample shape) and that calculated for an oblate spheroid of the same axial ratio, tending toward the latter at low temperatures. It is found that the spectroscopic splitting factor g is 2.00 ± 0.02 below 0°C, changing smoothly to 1.94 ± 0.02 at 28°C in the paramagnetic region. This latter value agrees well with those reported

by Kip and by Popplewell and Tebble. The g value at low temperatures implies that the Gd^{3+} ions are indeed in $^8S_{7/2}$ configurations without orbital angular momentum. It is concluded that the observed $7.5\mu_b$ per atom derives from the sum of the f-core electronic moments and the s-conduction electron polarization. This is contrary to other suggestions that the f-s interaction results in antiparallel alignment of those magnetic moment contributions. (auth)

38066 EFFECT OF ELECTRON CONCENTRATION ON MAGNETIC EXCHANGE INTERACTIONS IN RARE EARTH CHALCOGENIDES. Holtzberg, F.; McGuire, T. R.; Methfessel, S.; Suits, J. C. (IBM Watson Research Center, Yorktown Heights, N. Y.). pp 470-1 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The magnetic and electric behavior of pseudo-binary solid solutions between the semiconducting rock salt compound EuSe and the metallic rock salt compounds GdSe and LaSe are described. It is found that partial replacement of the divalent Eu ions by trivalent lanthanides such as Gd, Tb, Dy, Lu, La, and Y increases the paramagnetic Curie temperature of europium chalcogenides sharply in the low concentration range, where the material is still semiconducting. The Curie temperature variation in metallic samples with higher trivalent ion concentrations agrees with the assumption of indirect exchange interaction resulting from conduction electrons in the 5d energy level. (L.B.S.)

38067 MAGNETIC PROPERTIES OF RARE EARTH NITRIDES. Busch, G.; Junod, P.; Levy, F.; Vogt, O. (Eidgenoessische Technische Hochschule, Zurich). pp 472-3 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Paramagnetic susceptibilities of rare earth nitrides were measured by the Faraday method in magnetic fields up to 13 KOe between 1.5 and 750°K. The magnetizations at low temperatures were measured in pulsed fields up to 130 KOe. The physical properties are tabulated and the results are briefly discussed. (L.B.S.)

38068 EFFECTS OF DILUTION AND LATTICE CHANGES ON EXCHANGE INTERACTIONS IN EUROPIUM CHALCOGENIDES. McGuire, T. R.; Shafer, M. W.; Palmer, W. (IBM Watson Research Center, Yorktown Heights, N. Y.). pp 474-7 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The effects of dilution and lattice changes on exchange interactions were investigated in five europium chalcogenide systems; $(EuSe)_{1-x}(EuTe)_x$, $(EuS)_{1-x}(EuSe)_x$, $(EuS)_{1-x}(SrS)_x$, $(EuS)_{1-x}(NaEuS_2)_{x/2}$, and $(EuS)_{1-x}(KEuS_2)_{x/2}$. All compositions have the rock salt structure except those near $(NaEuS_2)$ and $(KEuS_2)$ which are hexagonal. In general, the lattice constants change linearly with x but in the Na system a non-linear decrease occurs. Magnetic moment measurements were made between 4.2°K and 300°K and indicated that all compounds, except those of high dilution and those containing tellurium, were ferromagnetic ($T_c <$ 18°K). In the paramagnetic region the susceptibility obeys the Curie-Weiss law, from which values of the θ intercept were obtained. From these studies it is concluded that, the effect of trivalent europium is to further dilute the magnetic structure, the value of θ, which is the sum of the exchange interactions, decreases approximately linearly with dilution when lattice parameter variations are allowed for, and the θ values are consistent with the exchange parameters deduced using the molecular field theory for the original europium chalcogenides. (auth)

38069 THERMODYNAMICS OF THE FERROMAGNETIC EUROPIUM SALTS, BY THE TWO-PARTICLE CLUSTER APPROXIMATION. Callen, H. B. (Univ. of Pennsylvania, Philadelphia); Callen, E. pp 478-9 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The two-spin cluster approximation was studied and evaluated for the case of ferromagnets with nearest and next-nearest neighbor exchange. A Curie temperature of 16.9°K is predicted for EuS. Calculations were also made of magnetization curves as functions of applied field and temperature, the ^{5} spin-correlation function of nearest and next-nearest neighbor spins, and the specific heat. (L.B.S.)

38070 DYNAMICAL PROPERTIES OF SOME RARE EARTH INTERMETALLIC COMPOUNDS. Kitano, Y.; Specht, F.; Trammell, G. T. (Rice Univ., Houston, Tex.). pp 480-2 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The band structure which is discernible in the crystal level structure of the large J second half rare earth in cubic crystal fields is discussed. In the compounds which are considered, the principal static and dynamic properties are determined by the properties of the low energy band. The spin waves in these substances consist of both longitudinal and transverse varieties, and expressions for their relations are obtained. (auth)

38071 MAGNETIC PROPERTIES OF SOME NEW COMPOUNDS CONTAINING RARE EARTH OXIDES. Schieber, M.; Gordon, R. G.; Hou, S. L. (Harvard Univ., Cambridge, Mass.). pp 499-501 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Orthorhombic compounds with a formula SrR_2O_4 (R = Eu, Gd, Dy and Ho) were synthesized and their magnetic susceptibilities measured between 1.5 and 300°K. It is found that $SrGd_2O_4$ and $SrTb_2O_4$ (with a different structure) are antiferromagnetics with Néel temperature of 2.8 and 5.9°K respectively. $SrDy_2O_4$ is paramagnetic above 1.5°K. $SrEu_2O_4$ and $SrHo_2O_4$ show a very strong effect of second-order paramagnetism. For $SrEu_2O_4$ a splitting of 410°K is found between the ground state (J = 0), and the first excited state (J = 1). A splitting of about 18°K was found between the ground state singlet and the center of gravity of an undetermined number of upper singlets, responsible for the second order Zeeman paramagnetism of $SrHo_2O_4$. (auth)

38072 FERROMAGNETISM IN THE SYSTEM DYSPROSIUM-HYDROGEN. Hubbard, W. M.; Brown, R. E.; Haben, J. F. (Naval Ordnance Lab., Silver Spring, Md.). pp 525-6 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Incremental susceptibility measurements on a series of dysprosium hydrogen compounds show that the Néel points in these materials are not monotonic functions of conduction electron concentration. In addition, the positive Weiss temperatures and the magnetic behavior in applied fields noted for the hexagonal hydrides suggest a complicated spin structure for these materials since no ferromagnetism is observed in these compounds down to 0.25°K. (auth)

38073 SUB-LATTICE MAGNETIZATIONS IN RARE EARTH IRON GARNETS MEASURED BY THE MOESSBAUER EFFECT. Huefner, S. (Technische Hochschule, Darmstadt, Ger.); Kienle, P.; Wiedemann, W.; Frey, J.; Zinn, W. pp 672-7 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The hyperfine splittings of the 14.4 kev γ radiation of ^{57}Fe in GdIG and ErIG were measured between 20°K and 565°K and those of the 80.6 kev γ radiation of ^{166}Er in ErIG between 4.2°K and 85°K using the Mössbauer technique. Both nuclear resonance absorption spectra revealed two different internal magnetic fields H_i showing distinct temperature dependence (with ^{166}Er only below 30°K). They could be assigned to the ferric ions at a and d sites and to the Er^{3+} ions at two magnetically inequivalent c sites (c_1, c_2). H_i extrapolated to 0°K are 5.50×10^5 Oe for the a sites, 4.85×10^5 Oe for the d site, 5.55×10^6 Oe for the c_1 site and 3.90×10^6 Oe for the c_2 site. From the H_i the effective magnetic moments (μ) of the Fe^{3+} and Er^{3+} ions at the different lattice sites could be deduced. They are compared with available molecular field calculations of the individual sub-lattice magnetizations and with bulk magnetization data of YIG and ErIG. From the temperature dependence of the

different $\langle\mu\rangle$ of Er^{3+}, the splittings of the lowest Kramers' doublets by the exchange field were estimated. (auth)

38074 FIELD-DEPENDENT ANISOTROPY IN GADOLINIUM. Graham, C. D. Jr. (General Electric Research Lab., Schenectady, N. Y.). pp 740-1 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

The anisotropy of gadolinium was studied in detail by torque measurements on a single-crystal disk from −196 to 70°C and in fields from 0 to 20 KOe; magnetization measurements were made over approximately the same range. The variations of the anisotropy constants with applied field and with magnetization are shown. The Curie point was found from the magnetization data to be 20°C. (L.B.S.)

38075 BASAL PLANE MAGNETOCRYSTALLINE ANISOTROPY IN SINGLE CRYSTAL GADOLINIUM. Darby, M. I.; Taylor, K. N. R. (Univ. of Durham, Eng.). pp 742-3 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Measurements were made of the basal plane magnetocrystalline anisotropy of single crystal gadolinium using a torque magnetometer. The basal plane anisotropy constant K_4 was determined between 65°K and 320°K and is found to be small compared with the uniaxial anisotropy constants. K_4 increases rapidly below 100°K and is found to be 4.2×10^3 erg cm^{-3} at 65°K. Polar energy diagrams are included which show how the easy direction of magnetization varies with temperature. (auth)

38076 THE TEMPERATURE VARIATION OF MAGNETOCRYSTALLINE ANISOTROPY FOR NICKEL AND GADOLINIUM. Birss, R. R.; Wallis, P. M. (Univ. of Sussex, Eng.). pp 744-7 of Proceedings of the International Conference on Magnetism. London, The Institute of Physics and The Physical Society, [1965].

Measurements of magnetocrystalline anisotropy were made on single crystals of nickel and gadolinium within the temperature range 92°K to 347°K. At room temperature a direct measurement on a (111) nickel disk gives a value of the second anisotropy constant (appropriate to infinite field) of $K_2 = -2.38 \times 10^4$ erg cm^{-3}. For nickel the variation with temperature of K_1 is in satisfactory agreement with published data but that of K_2 is not. For gadolinium the variation with temperature of the semi-angle of the cone of easy magnetization appears to be in slightly better agreement with the 1962 results of Graham than with those of Corner, Roe and Taylor. (auth)

REACTOR TECHNOLOGY

General

38077 (BNL-900) NUCLEAR ENGINEERING DEPARTMENT ANNUAL REPORT, DECEMBER 31, 1964. (Brookhaven National Lab., Upton, N. Y.). Contract AT-30-2-GEN-16. 213p. Dep.; $6.00(CFSTI).

Research and development activities are summarized in sections on reactor physics, chemistry and chemical engineering, hot laboratories, metallurgy, and engineering. Separate abstracts were prepared for each section except on engineering. (J.R.D.)

For abstracts of individual sections see: 36216, 36451, 36452, 36949, and 37202.

38078 (GEAP-4805) MANTA—MIXING ANALYZED NODAL THERMAL-HYDRAULIC ANALYSES. Armour, S. F.; Smith, D. L. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb. 1965. Contract AT(04-3)-189. 108p. Dep. mn; CFSTI, $4.00 cy, $0.75 mn.

The MANTA code provides a thermal-hydraulic analysis of as many as 200 nodes in a single segment and as many as 20 segments may be linked consecutively to each other in the axial direction. MANTA accounts for the heat transfer and pressure drop that may occur between coolant channels due to mixing as well as to the conventional heat transfer and pressure drop relations due to friction, discontinuities, acceleration, convection, conduction, and radiation. MANTA allows for the calculation at each node of the material properties viscosity, specific heat, conductivity, and specific volume to correspond to the actual node temperature being solved for. As many as six coolant gases (steam included) and nine materials (UO_2 included) may be included in the analysis of a single problem. The flow direction in the coolant channels may be specified as up or down thereby permitting the analysis of two-pass as well as single-pass fuel elements. (auth)

38079 (HW-84608) PHYSICS RESEARCH QUARTERLY REPORT, OCTOBER–DECEMBER 1964. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). June 15, 1965. Contract AT(45-1)-1350. 86p. Dep.; $3.00(cy), 2(mn) CFSTI.

Six papers are included; separate abstracts have been prepared for all. (T.F.H.)

For abstracts of individual papers see: 37511, 37512, 38126, 38127, 38266, and 38267.

38080 (HW-84609) RESEARCH AND DEVELOPMENT PROGRAMS EXECUTED FOR THE DIVISION OF REACTOR DEVELOPMENT. Quarterly Progress Report, October–December 1964. Green, J. K. (ed.) (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Dec. 1964. Contract AT(45-1)-1350. 81p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Progress is reported in sections on analytical studies and advanced concepts, chemical research and development, fuels studies, gas-cooled reactor studies, instrumentation and nondestructive testing, radiation effects on materials, and Plutonium Recycle Test Reactor operation and related functions. Separate abstracts were prepared for each section. (J.R.D.)

For abstracts of individual sections see: 36535, 36749, 36953, 37166, 37167, 38081, and 38268.

38081 (HW-84609(p.3.1-16)) ANALYTICAL STUDIES AND ADVANCED CONCEPTS. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Results of economic studies of 1000-Mw(e) reactor designs are summarized. Other cost studies are described for bred fuels in PWR, and Pu and ^{235}U enrichment of Th fuels. Advanced studies are described on organic cooled heavy water reactors, nitride fuels, high temperature lattice test reactor mockup, and Phoenix fuels. (J.R.D.)

38082 (ORNL-3807, pp 177-88) STUDIES FOR ADVANCED SYSTEMS. Perry, A. M.; Witt, F. J. (Oak Ridge National Lab., Tenn.).

Fuel-cycle cost calculations were extended to the consideration of Pu–Th fuel cycles in which the bred U is recycled but the Pu in the discharged fuel is sold or discarded. The recycle of the uranium but not the plutonium gave higher conversion ratios (0.9 or above) than could be obtained by recycling both the uranium and the plutonium. It was found that by not recycling the Pu, full advantage is taken of the bred ^{233}U, but the ^{242}Pu is not allowed to build up to levels at which it becomes a significant poison. A He-cooled fast reactor was studied with respect to its response to various types of accident conditions. For this study a computer program was developed that solves the point kinetics equations and hot-channel heat transfer equations in alternating successive finite time steps to determine the axial and radial temperature distribution in the hot-channel fuel pin and the axial temperature distribution in the coolant gas. The types of transients studied were those produced by step and ramp reactivity insertions and by loss of coolant pressure and flow. The effects of these perturbations on the reactor with and without control rod action to stop the resulting excursions were studied. Codes for analyzing pressure vessels including the unified shell analyzer that provides for analyses of vessels made up of several different types of shells, and the CERL-II code for calculating the stresses in a hemispherical shell with a radially attached cylindrical nozzle were developed. The model for studies of nozzle-to-shell attachments was modified and experimental data were obtained. These data are in satisfactory agreement with theoretical results in both distribution and magnitude, with one exception; that is, the outer surface meridional stresses on the sphere are not in agreement. The maximum stresses are, however, in good agreement in all cases. (auth)

38083 (WAPD-T-1791) ANALYTICAL MODEL FOR BLOWDOWN EXPERIMENTS. Margolis, S. G.; Redfield, J. A. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1965. Contract AT(11-1)-Gen-14. 15p. (CONF-650602-31) Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

A model is described which has been found useful in describing the blowdown of simple tanks containing a two-phase steam–water mixture. Pressure in the vessel is found from overall mass and energy balances. A separate mass balance on the steam held as bubbles in the lower phase determines the level of the two-phase mixture. Efflux is calculated using the Moody correlation. Good agreement with experiment has been observed for both high and low leaks ranging from 1 inch to 3.75 inches in diameter. (auth)

38084 EXPERIMENTAL AND PRACTICAL REACTORS. Uno, Hidero (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 11: No. 4, 15-20(Apr. 1965). (In Japanese)

The first reactors in Japan were set up in 1955. Within eight and a half years after this date, eight reactors were operative. These included: JRR-1 (water boiler), JRR-2 (CP-5 type), JRR-3 (natural uranium, heavy water moderated), JPDR (experimental power), JRR-4 (atomic powered ship reactor), and TCA (light-water critical assembly). Plans for a material testing reactor (JMTR) are complete. The acquisition history and operating behavior of each operational reactor is described together with special items specific to individual reactors. (TTT)

38085 SOME APPLICATIONS OF A MULTIMODE GENERALIZATION OF THE INHOUR FORMULA. Henry,

A. F.; Kaplan, S. (Westinghouse Electric Corp., West Mifflin, Penna.). Nucl. Sci. Eng., 22: 479-86(1965). (WAPD-T-1765)

By expressing the fluxes associated with a range of experimental period measurements as linear combinations of several trial functions, a generalization of the inhour formula relating measured periods to linear functionals of the perturbation is obtained. The formula is applied to finding the fast periods and values of k_{eff} associated with the early stages of super-prompt critical-burst experiments or pulsed die-away experiments. By appropriate choice of trial functions, the formula may be rearranged so that it relates period to a single reactivity-like quantity and other small corrections. Since this quantity is a linear functional, values of it corresponding to different perturbations are additive, even when the over-all flux shapes associated with these perturbations differ. When two trial functions alone are sufficient for a range of experiments, further rearrangement results in a relation that has the form of the so-called seven-group inhour equation. (auth)

38086 RESONANCE INTEGRAL FOR THE DOPPLER MEASUREMENT IN FAST REACTORS BY THE FOIL-ACTIVATION TECHNIQUE. Reynolds, A. B. (General Electric Co., San Jose, Calif.). Nucl. Sci. Eng., 22: 487-9(1965).

An expression is presented for the effective resonance integral of an individual resonance in a foil as a function of the foil temperature. The effect of scattering by the furnace material is shown to be important. (D.C.W.)

38087 DYNAMIC ANALYSIS OF COOLANT CIRCULATION IN BOILING WATER NUCLEAR REACTORS. Sanathanan, Chathilingath K. Thesis, Cleveland, Case Inst. of Tech., 1964. 99p.

The dynamics of two-phase flow through the coolant channels of a natural-circulation boiling-water nuclear reactor is studied analytically. One-dimensional conservation equations describing the flow through each channel are written in the linearized perturbed form and Laplace transformation in time is performed. A systematic procedure is developed to approximate the solution. It is found that the solution may be oscillatory both in time and space, and that the stability depends largely upon the steady-state profile of velocity and void fraction along the channel as well as the channel length. The simplifying assumption made by earlier investigators that the slip ratio is constant along the channel length is shown to yield results close to the true solution. The solution gives the space-time dependent transient steam void fraction, which, when multiplied by the reactivity worth of void, yields the space-time dependent void reactivity. Coupling between parallel channels due to a common downcomer is investigated. Several specific problems are considered and the predicted solutions are substantiated by comparison with those obtained through elaborate numerical methods and previous observations. The analytical techniques developed are applicable to both natural and forced circulation systems. (Dissertation Abstr.)

38088 A SMALL VERSATILE DATA COLLECTING SYSTEM FOR EXPERIMENTAL REACTOR PHYSICS. Bjoerkman, J. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 449-57 of Automatic Acquisition and Reduction of Nuclear Data. Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1964.

Equipment for automatic acquisition of nuclear data is briefly described. The system accepts all kinds of signals from a reactor, both pulses from pulse-type detectors and analog voltage signals. The analog signals are sampled and converted into digital form. The collected data are read out and transferred either direct to a computer or to an output recorder. The system features a high degree of flexibility. The central instrument consists of three main units, a control unit for reading and writing the information, a register unit for collecting and temporarily storing the input data and a program unit. The register and program units are constructed on a plug-in board system. They each contain a number of positions in which standardized circuits mounted on plug-in boards can be inserted. The user itself may set up the scalers in the register and the logics in the program unit required for specific experiment. Because of its flexibility the equipment is employed for a wide range of nuclear measurements. The applications for measuring period, noise and transfer functions of a reactor are described. Although being primarily a data collector simple additions and subtractions can be performed in the register unit of the instrument. Using this it is possible to obtain a certain amount of data handling and reduction within the system. (auth)

Auxiliaries and Components

38089 (DP-926) A SCRAM BYPASS SYSTEM USING ZENER DIODES AS LOGIC ELEMENTS. Woodward, William J. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). June 1965. Contract AT (07-2)-1. 7p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A control chassis containing a group of reactor scram relays is described. A bypass switch is provided for each of the relays, but a zener diode logic circuit requires a certain minimum number of relays not to be bypassed before the reactor can be started up. The reactor is scrammed when any one of the unbypassed relays calls for a scram, or when less than the minimum number of scram relays is in service. (auth)

38090 (GEMP-88) REACTOR INSTRUMENTATION AND CONTROL PROGRESS REPORT NO. 88. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). May 28, 1965. Contract AT(40-1)-2847. 23p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Progress in the development of a probe-type temperature sensor is reported. Resonance time measurements of a single-crystal alumina sensor in a fast-moving gas stream were continued. A molybdenum and alumina sensor was tested up to 2000°C in a non-oxidizing atmosphere. A transistorized readout circuit for use with the 2000°C sensor as a complete temperature measurement system was further developed and packaged. Progress in the development of advanced nuclear sensors for use in monitoring and controlling high-temperature, high-performance reactors is also reported. Construction was started on two ground-ring a-c ionization chambers. Single-lead a-c chambers and a-c [illegible]wer range control system components were tested at the Bulk Shielding Facility at ORNL. Investigation of magnetic fields as a means of improving output current stability of unpowered charged-fragment thermal neutron sensors was continued. Unpowered thermal-neutron sensors utilizing capture gamma rays and internal conversion electrons to produce a fast-response output current were constructed and tested. (M.C.G.)

38091 (GEMP-90) DEVELOPMENT OF NUCLEAR SENSORS. Final Report. Stentz, R. H.; Treinen, R. L. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). June 25, 1965. Contract AT(40-1)-2847. 49p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

The results of a program to develop advanced nuclear sensors for general use in the nuclear industry for monitoring and controlling high-temperature, high-performance reactors are presented. Most of the effort centered on the development of two new types of sensors, the a-c ionization chamber and the charged fragment detector. Various types of alternating current neutron-sensitive ionization chambers were designed and tested for both ambient and high-temperature operation. Some of these chambers displayed unique advantages when compared to d-c chambers. Specialized auxiliary electronic equipment was also constructed to facilitate testing of these chambers. A-c chambers and auxiliary electronic units were satisfactorily adapted for use in a power-range regulating-rod control system. The charged-fragment thermal-neutron sensor

concept was adequately tested, but reliable operation was achieved only when external power was applied to the sensor. The powered version of the sensor concept offers excellent possibilities for high-temperature and in-core-flux monitoring applications. The concept of utilizing radiative capture of thermal neutrons to devise an unpowered, fast response thermal-neutron sensor was satisfactorily demonstrated. Unpowered gamma-sensitive sensors were also tested and found to be practical for high gamma flux applications. (auth)

38092 (IITRI-578P21-9) STUDIES OF REACTOR CONTAINMENT. VOLUME I. DETERMINATION OF THE EQUATION OF STATE OF A POROUS SOLID. Task Two Final Report. Lieberman, Paul (IIT Research Inst., Chicago, Ill.). [nd]. Contract AT(11-1)-578. 295p. Dep.; $6.00(cy), 6(mn) CFSTI.

A helium/air shock tube is designed to give controlled blast waveforms for impingement against a porous solid contained in a special specimen holder. The sensors in the specimen holder are arranged to detect elastic wavefront, plastic wavefront, reflected plastic wavefront, unloading wavefront, particle velocities in the crushing solid, and gas pressure in the impingement gases. The data records are interpreted in terms of a wave diagram from the pressure-time histories at several stations along the specimen holder. The wave diagrams for several blast impingement pressures are combined to construct the equation of state of the porous solid in loading and in unloading. The Hugoniot up to 1,700 psi is determined for balsa wood by a series of twenty tests. Since no temperature, strain-rate, and friction effects were detected in these tests, the dynamic and static stress-volume relations are equal. Three unloading paths for balsa, each test conducted with wood of the same specific gravity, were determined by three additional tests. The unloading paths are originated from 15,450-, 9,400-, and 6,650-psi states. The additional Hugoniot data contain no temperature or strain-rate effects, but do show that wall friction effects at the high-stress amplitudes are reduced in the dynamic tester, as compared with the static tester. The unloading isentrope paths from each of the Hugoniot points are shown by two straight lines in the stress-volume plane, and the slope of the isentrope path is steeper with increased severity of blast impingement. This work was undertaken to provide information for choosing materials and designing blast shields in connection with reactor containment. (auth)

38093 (JUL-BIBL-8) AUSWECHSELVERFAHREN AN REAKTOREN. (Exchange Methods in Reactors). Krueger, F. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Sept. 1964. 19p. Dep.(mn).

A bibliographic compilation of the methods used for exchange and replacement in reactors is presented. It is divided into sections on devices for the exchange of fuel elements, devices for the exchange of experimental inserts and holders, exchange devices for vertical and horizontal introduction, and exchangeable irradiation devices at various reactor types. (J.S.R.)

38094 (ORNL-tr-587) CONTROL ELEMENT FOR NEUTRON REACTORS. Translated for Oak Ridge National Lab., Tenn., from Italian Patent No. 618,925. July 2, 1960. 14p. Dep.(mn); $1.60(fa), $0.80(mf) JCL.

The design and fabrication of ^{10}B-containing reactor poison rods having a radially varying B concentration are described. The concentration variation provides a long irradiation lifetime for the use of the poison rods in reactors. (T.F.H.)

38095 SOME IDEAS ON THE UTILIZATION OF CONCRETE CONTAINMENTS. Koenne, W. (Oesterreichische Elektrizitaetswirtschafts, AG, Vienna). Nucl. Struct. Eng., 2: 126-33(July 1965). (In German)

Some ideas and suggestions for the utilization of concrete as a containment structural material are discussed. It is shown that concrete can be used expediently only if an attempt is not made to achieve simulation of individual qualities of steel with it, but if, starting from the properties and potential of this material, appropriate ideas of construction are pursued. When considering the variation of internal pressure with time, attention should be paid to the utilization of the large heat capacity of concrete. More realistic insight in the stress field within the concrete wall can be gained by this method. Lowering of internal temperature also causes internal pressure decreases, thus giving rise to rapidly changing leak rates. For reasons of construction and of protection against radiation it is often necessary to plan an intermediate space, which, together with the decreasing internal pressure and the large thickness of the wall, affects the overall leak rates. (auth)

38096 IMPROVEMENTS IN NUCLEAR REACTORS. Wordsworth, Alfred Derrick (to Babcock and Wilcox Ltd.). British Patent 989,167. Apr. 14, 1965. Filed Aug. 19, 1960.

In gas cooled reactors having a core with fuel channels and a vessel enclosing the core formed with standpipes for refuelling the various channels, additional standpipes coaxial with the channel are provided for removably mounted leads of thermocouples means extending to the core fuel element channel. During a refuelling operation, the leads in cable form are stored in a magazine arranged to be carried on the top of the fuel element being fed by a refuelling machine into the reactor. Grabbing means are provided on the refuelling machine for extending the cable from the fuel element to a shield plug in the additional standpipe. The lower end of the cable is connected to the fuel element by means that include a rupture link of less tensile strength than the cable so that the weakest link breaks when stress is applied to the cable to remove it from a spent fuel element. The grab raises the thermocouple lead magazine into a socket in the shield plug in the additional standpipe, and entry of the magazine into the socket effects a fluid-tight seal between the magazine and shield plug. The magazine is disengaged from the grab and automatically locked in the standpipe. Co-operating guide means on the shield plug and the displaceable member from the magazine are adapted to rotate the member on entering the shield plug socket in order to align pin inserts of an electrical plug on the one with socket inserts on the other. The electrical plug and socket connection serves to connect electrically thermocouple means to thermocouple monitoring instruments outside the reactor. (B.L.M.)

38097 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Langdon, Kenneth Thomas Peers; Smith, Albert William Richard (to Babcock and Wilcox Ltd.). British Patent 989,168. Apr. 14, 1965. Filed Mar. 1, 1961.

A coupling device is provided for fuel elements for a gas-cooled reactor that enables the elements to be lowered into the fuel channel as a continuous string but becomes inoperative to allow the irradiated elements to be removed singly and stored in a refuelling machine. The fuel elements are provided at an upper end with centrally disposed pivotally mounted members having ends with hooks extending inwardly and downwardly when in an operative position to engage complementary means at the lower end of an adjacent fuel element. The lower end of the adjacent fuel element is provided with an axial projection upwardly hooked for cooperation with hooked members similar to those at the upper end of the fuel element. (B.L.M.)

38098 SELF-ADJUSTING NEUTRON ABSORBER FOR THE CONTROL OF NUCLEAR REACTORS. (to Agip Nucleare S.p.A.). British Patent 991,004. May 5, 1965. Priority date Nov. 29, 1960, Italy.

A self-adjusting neutron absorber is adapted to oppose the phenomena of distortion and instability in the neutron flux distribution in a nuclear reactor that employs uranium as a fuel, graphite as a moderator, and gas as a coolant. The absorber presents mobile and fixed surfaces apt to absorb neutrons. Elements responsive to variations in the temperature of the coolant gas or in the neutron flux are connected directly to the mobile surfaces, so that the variations cause movement of the mobile surfaces relative to the fixed surfaces resulting in corresponding variations in the area of neutron-absorbing surface. A large number of

these absorbers can be introduced into a reactor core to achieve finely distributed regulation. (A.G.W.)

38099 NUCLEAR FUEL ELEMENTS. Eltham, Barry Edward; Franklin, Norman Laurence (to United Kingdom Atomic Energy Authority). British Patent 992,164. May 19, 1965. Filed May 13, 1963.

A method is patented for detecting swelling of the sheath of a nuclear fuel element of the type consisting of a flat bar of nuclear fuel material enclosed in a finned protective sheath. An elongate impermeable fragile body is secured adjacent to the outside of the sheath and in a position of inferior heat transfer through the sheath. Swelling of the sheath in the vicinity of the body imparts a bending moment to the body to cause it to break and release a detectable substance confined in the body. (A.G.W.)

38100 LEAKAGE PREVENTION. (to Westinghouse Electric Corp.). British Patent 992,455. May 19, 1965. Priority date May 24, 1963, United States.

An arrangement for containing fluid under pressure includes a sealed inner container enclosing pressurized fluid-handling equipment and a sealed outer container surrounding and spaced outwardly from the inner container. The pressure in the space between the containers is maintained less than that within the inner container and less than that outside the outer container. All leakage into the space enclosed by the two containers is pumped into the inner container. A structural biological shield surrounds and engages the outer container so as to receive and withstand any outwardly acting forces. The arrangement is particularly suitable for containing a nuclear reactor system. (A.G.W.)

38101 WASTE HEAT STEAM GENERATOR, WHOSE HEATING GAS IS FORMED BY THE COOLING GAS OF A GAS-COOLED NUCLEAR REACTOR. Taylor, Antony James; Worley, Norman George (to Deutsche Babcock and Wilcox-Dampfkessel-Werke). German Patent 1,189,559. Mar. 25, 1965. Priority date Sept. 29, 1958, Great Britain.

A plant is described, which includes a gas-cooled nuclear reactor, vapor generating means, an economizer, means for passing coolant successively from the reactor to the vapor generating means, then to the economizer and subsequently back to the reactor, a separator drum, means for leading operating fluid from a source through the economizer to the separator drum, and means for circulating operating fluid from the separator drum through the vapor generating means. Means are also provided for regulating the temperature of the coolant at the inlet to the nuclear reactor, the means including means for leading operating fluid from the liquid space of the separator drum through the economizer and means responsive to the temperature of coolant returning to the reactor and adapted to control the flow of operating fluid from the separator drum to the economizer. (Gmelin Inst.)

38102 HOLDING DEVICE FOR PRESSURE TUBES CONTAINING FUEL MATERIALS AND FOR COOLANT FLOW. Guidi, Eugen (to Gebrueder Sulzer AG). German Patent 1,191,500. Apr. 22, 1965. Priority date June 8, 1960, Switzerland.

The tubes are attached to a connection head, which is provided with distribution and collecting pipes by means of a movable joining element, which presses one end of the pressure tube against the connection head. Between the joining element and the connection head there is an elastic member, e.g. a plate spring, the elasticity of which may be varied by proper means. (Gmelin Inst.)

38103 MANIPULATOR FOR DISMANTLING AND FASTENING PRESSURE TUBES CONTAINING FUEL PARTICLES, FIXED IN SPECIAL FASTENING HEADS IN A NUCLEAR REACTOR. Guidi, Eugen (to Gebrueder Sulzer AG). German Patent 1,191,501. Apr. 22, 1965. Priority date June 8, 1960, Switzerland.

The manipulator, which is outside the shielding, is provided with concentric tubes, which may be introduced into the reactor through an opening in the shielding. Each of the manipulator tubes carries tools that are, together, capable of actuating the holding device of the pressure tubes. Each of the manipulator tubes may be moved independently of the others by means of separate driving devices. (Gmelin Inst.)

38104 LOADING DEVICE FOR FUEL CHANNELS OF A NUCLEAR REACTOR. Adler, George Fritz Werner; Billingham, Kenneth Arthur (to The English Electric Co. Ltd.). German Patent 1,191,918. Apr. 29, 1965. Priority date June 15, 1959, Great Britain.

The transfer device described is for loading and/or unloading the fuel elements of a nuclear reactor of the kind in which the elements are positioned in transversely spaced vertical fuel channels within the reactor. The transfer device includes a main transfer tube adapted to be inserted vertically downwards into the reactor, a movable transfer tube incorporating at least one hinged joint and arranged for movement with the main tube to one or more positons in which the lower end of the movable transfer tube is spaced transversely from the main tube, and a grabhead cable guide within the hinged joint coupled mechanically to the joint so that when the joint is unflexed the guide lies in a position allowing free movement of fuel elements through the joint, whereas when the joint is flexed the guide moves automatically to a position to guide the grabhead cable around the joint. (Gmelin Inst.)

38105 SEQUENCE CONTROL FOR THE SELF-EXCITATION CAPABILITY OF NUCLEAR REACTORS. Samuel, Claude (to Indatom S.A.R.L.). German Patent 1,194,513. June 10, 1965. Priority date Dec. 3, 1958, France.

A neutron flux detector was adapted to supply an electric signal proportional to the power of the reactor. A correcting circuit which has an increasing gain with frequency, was connected to the flux detector and produced an output signal, which varied with the rate of change of the electric signal. Stabilizing means adapted to absorb neutrons to an adjustable extent inside the reactor core were used. A method using the output signal from the correcting circuit to effect a change of the neutron-absorbing capacity of the stabilizing means proportional to the output signal was developed. (Gmelin Inst.)

38106 SAFETY DEVICE FOR AVOIDING THE EJECTION OF FUEL CARTRIDGES DURING THE UNLOADING OF VERTICAL CHANNELS OF AN ATOMIC REACTOR. Dequenes, Pierre (to Electricite de France). German Patent 1,194,991. June 16, 1965. Priority date Nov. 15, 1961, France.

In a nuclear reactor cooled by a pressurized gas means are provided for reducing the pressure gradient along the coolant channel to be unloaded. These means consist of radially directed openings at the exit of the channels through which a gas stream by-passed from the main circuit flows into the channel. (Gmelin Inst.)

38107 FUEL ELEMENT HANDLING DEVICE. Millot, Jean; Mulot, Pierre (to Commissariat à l'Énergie Atomique). U. S. Patent 3,175,720. Mar. 30, 1965. Priority date Feb. 3, 1961, France.

A handling device, particularly for reactor fuel elements, includes a supporting framework, a carriage movable in the framework, and a tubular body mounted on the carriage. Gripping jaws are mounted on the lower extremity of the body, and a control rod is mounted in the body for opening and closing the jaws. The axial movements of the rod are controlled by a gear reducing motor unit and a screw-bolt assembly. The unit and the assembly are connected by a gear train that is made up of a driving pinion and a driven pinion. The drive of the driven pinion is carried out by a connecting pinion that is able to move parallel to its rotation shaft by means of a mobile pin for decoupling the driving pinion from the driven pinion and preventing the movement of the jaws. (B.L.M.)

38108 NUCLEAR REACTORS. Lee, Ralph; James, Dennis (to United Kingdom Atomic Energy Authority). U. S. Patent 3,175,854. Mar. 30, 1965. Priority date Jan. 9, 1961.

A grab of the sequentially operating type is described that that is suitable for engaging and lifting a tubular container and allowing passage of articles, such as fuel elements, through the grab into the container. The grab includes a tubular grab body, an assembly of coupling members carried by the grab body, and an assembly of engageable members carried by the tubular container. The coupling members define a track along which the engagable members move during coupling and uncoupling of the container and grab body. The track has entry and exit points and lifting positions between these points. Coupling of the grab with the container is effected by lowering the grab body to locate the container when it is in an independently supported position and then by raising the grab relatively to the supported container so that the engageable members move into the track in the grab body through the entry points and then along the track to the lifting position. Uncoupling is effected by lowering the container to an independently supported position, lowering the grab body relatively to the container, and then raising the grab body so that the engageable members move along the track from the lifting positions to the exit points. A locking device is made up of a series of locking balls housed in holes in the grab body located in positions in the track between the lifting positions and exit points of the track. During locking the balls occupy a locking position projecting into the track and in a nonoperative position rest back in holes in the grab body. (B.L.M.)

38109 ELECTRIC CONNECTORS FOR NUCLEAR FUEL CARTRIDGES. Liermann, Jean (to Commissariat à l'Énergie Atomique). U. S. Patent 3,175,956. Mar. 30, 1965. Priority date Apr. 10, 1962, France.

A device provides for transmitting an electric potential difference from one fuel cartridge to another when these cartridges are in contact by their ends and approximately aligned. The potential difference may correspond to a measurement, such as temperature, obtained by means of a thermoelectric probe. A fixed central contact stud is disposed on the end plug of each cartridge, and a peripheral stud is supported by the upper edge of a resilient annular cup that is slightly curved and substantially equal in diameter to the plug. The cup is fixed to the plug concentrically with the central stud in such a manner that in the absence of stress the peripheral stud projects beyond the apparent contour of the remainder of the cartridge. The cartridges are provided with aligning members, and sheathed electric conductors extending through these aligning members connect like studs for each fuel cartridge. (B.L.M.)

38110 NUCLEAR REACTOR FUEL CHANNEL ASSEMBLY WITH NON-RETURN DEVICE. Costes, Didier; Peuchmaur, Alphonse (to Commissariat à l'Énergie Atomique). U. S. Patent 3,175,957. Mar. 30, 1965. Priority date May 27, 1961, France.

A non-return device is provided in a reactor fuel channel that prevents a fuel element from moving back once it has been inserted into the channel. A pawl constituted by resilient arms that are bent towards the axis of the channel and a member that butts axially against the channel wall make up the non-return device. A rolled thin metal sheet forming a tubular thimble that is elastically deformable in a radial direction fitted into a counterbore at the entrance of the channel constitutes one embodiment of the device. (B.L.M.)

38111 THERMAL BARRIER FOR NUCLEAR REACTOR VESSEL. Bourgade, Pierre (to Ste Indatom). U. S. Patent 3,175,958. Mar. 30, 1965. Priority date May 30, 1962, France.

A thermal barrier is provided for the prestressed concrete vessel of a gas cooled reactor that includes a nest of spaced tubes parallel to the surface of the concrete and through which the coolant circulates. The tubes are disposed between at least one thin (1 mm as a maximum) internal tube and a thicker (at least a few millimeters) external sheet in thermal contact with the tubes. The internal sheet is corrugated to facilitate thermal deformations. (B.L.M.)

38112 NUCLEAR REACTOR LOADING MACHINE. Lemesle, Georges; Martin, Roger; Monteil, Marcel; Roche, Roland; Rouge, Pierre (to Commissariat à l'Énergie Atomique). U. S. Patent 3,179,266. Apr. 20, 1965. Priority date Feb. 20, 1962, France.

A handling machine for transferring a plurality of articles, particularly fuel elements, into and from at least one channel of a reactor includes a magazine having a plurality of chambers for receiving the objects and a handling unit positionable in operative relation to the channel. Means are provided on the unit for engaging the magazine and for positively locking the magazine in fixed predetermined position relative to the unit. Grab means on the unit engage each of the objects. Means are provided for displacing the grab means relative to the unit and relative to the magazine between a position in which the grab means is engageable with an object contained in the channel and any one of a series of positions in which the grab means is engageable with an object contained in a selected one of the magazine chambers. (B.L.M.)

38113 SEALING PLUGS. Bradley, Norman; Jones, Jack (to United Kingdom Atomic Energy Authority). U. S. Patent 3,179,279. Apr. 20, 1965. Priority date Mar. 11, 1959, Great Britain.

A plug is described that is particularly applicable for sealing the stand-pipes providing access to the core of a steam cooled or steam generating reactor. The plug is made up of a plug body, means defining an annular projection about the periphery of the body, a coaxial sleeve member located by and movable relative to the body, and at least one pipe sealing ring of resilient material disposed between the annular projection and the sleeve member. The sealing means includes a spring component that tends to urge the sleeve member and the body member together to compress the ring. A weight member that is heavy enough to overcome the urging effect of the spring component is connected to the spring component and depending from the body. The interior of the pipe is provided with support means for supporting the weight of the weight member to allow the spring component to take effect. (B.L.M.)

38114 FINE CONTROL OF A SUSPENSION NUCLEAR REACTOR. Kersten, Johannes A. H. (to Stichting Reactor Centrum Nederland). U. S. Patent 3,184,389. May 18, 1965. Priority date Dec. 30, 1960, Netherlands.

Abnormal fluctuations of the power level in a reactor in which a circulating suspension of solid fissile material in water or heavy water is used as fuel can be controlled by addition of a soluble electrolyte that affects the hydrogen or deuterium ion concentration. The electrolyte, preferably NaOH or NH_3, is added automatically or nonautomatically until the abnormal fluctuations disappear. An arrangement for automatic control includes a continuously operating neutron flux meter, a differential amplitude controller with a low pass frequency band width limit, and a storage tank for electrolyte having an automatic control valve connected to the controller. (A.G.W.)

38115 SOLID MODERATOR CORE STRUCTURES FOR NUCLEAR REACTORS. Taylor, Roderick (to The Nuclear Power Plant Company Ltd.). U. S. Patent 3,186,916. June 1, 1965. Priority date Sept. 29, 1959, Great Britain.

Solid moderator core structures for gas-cooled reactors are designed to be keyed solidly to a supporting base plate and to provide compensation for irradiation growth or shrinkage and for differential thermal expansion. Three structures are illustrated in which blocks of neutron moderating material are arranged to permit movement in the direction of the axes of the channels in the core but to prevent movement in the direction transverse to the channel axes. Wedge-shaped members and blocks having mutually inclined plane surfaces are used to accomplish this result. (A.G.W.)

38116 FUEL ELEMENTS ADJUSTING DEVICES IN NUCLEAR REACTOR. Aranovitch, Eric; Bonnaure, Pierre; Calende, Sesto; Mollica, Guido (to Communaute

Europeenne de l Energie Atomique). U. S. Patent 3,188,276. June 8, 1965. Filed Feb. 7, 1963.

A device for adjusting the relative positions of fuel elements in a reactor includes two sets of guide bars symmetrically crossing one another at an angle of 90° in two superposed planes. The bars consist of parallel I-sections having spaces between them for carriages adapted to support fuel elements. The carriages are supported by the bars of one of the sets. The bars of each set are connected at their ends to displacement mechanisms, such as a system of articulated rhombuses, and the two bars that intersect one another on the axis of the lattice of the reactor are fixed in position. (A.G.W.)

38117 FUEL ELEMENT CHANGING AND TRANSPORTING APPARATUS FOR NUCLEAR REACTORS. Straub, Edwin; Bosshard, Ernst (to Sulzer Freres, S. A.). U. S. Patent 3,190,805. June 22, 1965. Priority date Feb. 12, 1960, Switzerland.

Connecting members for coolant-conveying pipes are combined with retaining members for fuel elements and are positioned permanently on one side of the reactor moderator unit designed to contain nuclear fuel elements. A changing apparatus on the opposite side of the moderator unit is adapted to insert fuel elements and present them for retention by the retaining members, and to receive fuel elements released by the retaining members, withdraw them from the moderator unit, and transport them to a storage chamber. The apparatus includes a radiation-proof cab for an operator, a radiation-proof container for fuel elements, and means for alignment with apertures in the moderator unit and the shaft leading to the storage chamber. (A.G.W.)

38118 DEVICE FOR SERVICING NUCLEAR REACTORS. Hosegood, Samuel Brittan; Collins, Bernard William; Harper, Cecil (to United Kingdom Atomic Energy Authority). U. S. Patent 3,192,119. June 29, 1965. Priority date Dec. 12, 1960, Great Britain.

A device for withdrawing reactor components from positions within a reactor core includes a casing arranged for manipulation by the reactor charge machine, gripping jaws carried by the casing, and means within the casing for exerting a force to detach the component from its mounting and for withdrawing the component into the casing. The device may be particularly adapted for the withdrawal of a nuclear fuel element mounting member from its supporting grid. (A.G.W.)

38119 NUCLEAR REACTOR CORE CONSTRUCTION. Campbell, John W. (to Babcock and Wilcox Ltd.). U. S. Patent 3,192,120. June 29, 1965. Filed Mar. 29, 1961.

The core of a heterogeneous liquid-moderated reactor includes rows of fuel element chambers alternating with rows of control rods each formed with four longitudinal ribs extending between fuel element chambers. The control rod ribs project sufficiently for the edges of neighboring ribs of different rods to lie adjacent one another. A core support includes sets of parallel grid members extending transversely of the control rods and at angles to the ribs to define compartments, the diagonals of which are parallel or substantially parallel to the ribs. (A.G.W.)

38120 BOILING COOLANT NUCLEAR REACTOR SYSTEM. Sprague, Theodore S. (to The Babcock and Wilcox Co.). U. S. Patent 3,193,468. July 6, 1965. Filed July 12, 1960.

In the reactor described the primary coolant is boiled in the core of a reactor and is then separated into vapor and liquid portions. The vapor portion is removed from the separator to a point of use in a prime mover. The liquid portion is passed into an enclosed space that contains both a heat exchange zone and a by-pass zone. In the heat exchange zone, the liquid is used to heat a secondary coolant before being recirculated to the core of the reactor. By controlling the amount of coolant passing through the heat exchange zone relative to the amount through the by-pass, the temperature of the recirculated coolant can be fixed. If the coolant used has a negative temperature coefficient of reactivity, it is possible to control the reactor by regulating the temperature of the recirculated primary coolant. (A.G.W.)

38121 CORE STRUCTURE FOR A VAPOR COOLED, WATER MODERATED NUCLEAR REACTOR. Bradley, Norman; Lawson, Donald Wilfred (to United Kingdom Atomic Energy Authority). U. S. Patent 3,193,469. July 6, 1965. Priority date Oct. 14, 1959, Great Britain.

Supports for the joints between pressure-resisting coolant tubes and inlet and outlet pipes in a vapor-cooled reactor are intended to relieve stresses produced by temperature changes. The support includes a pair of interlocking members to prevent relative twisting while permitting longitudinal expansion and contraction of the respective tube and preventing displacement of the pipe laterally of the tube. (A.G.W.)

38122 NEUTRONIC REACTOR STRUCTURE. Carleton, John T. (to U. S. Atomic Energy Commission). U. S. Patent 3,200,046. Aug. 10, 1965.

This patent covers the relative sizes of graphite blocks arranged in layers to form the moderator of a nuclear reactor having coolant tubes containing fuel elements cooled by liquid flowing thereover. The coolant tubes are lodged in perforated blocks located in alternate layers. The perforated blocks are of smaller cross section than the imperforate blocks so that at the top and one side of each perforated block there are spaces that accommodate growth of the perforated block due to the fact that the perforated block directly surrounds fissionable material. (AEC)

Criticality Studies

See also PHYSICS — Criticality Studies.

Refer also to abstract 38229.

38123 (AEEW-M-458) G.M.S.I—A GENERALISED MULTIGROUP SYSTEM OF CALCULATIONS USING THE IBM 7030 (STRETCH) COMPUTER. Gratton, C. P.; Smith, P. E. (Atomic Energy Establishment, Winfrith (England)). Feb. 1965. 27p. Dep.; BIS, $0.70; HMSO, 3s. 6d.

G.M.S. is a generalized system of reactor physics calculations written in the FORTRAN programing language for the IBM 7030 computer. The program will perform cell, supercell, and overall reactor physics problems within the limits of one dimension using either slab or cylindrical geometry. A description of the basic system is included. Data obtained from G.M.S.I calculations are presented. (M.O.W.)

38124 (GEAP-4580) FLUZ—A COMPUTER CODE FOR ANALYZING THE REACTOR RESPONSE TO SMALL REACTIVITY OSCILLATIONS. Greebler, P.; Hutchins, B. A.; Kelley, M. D. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar. 22, 1965. Contract AT(04-3)-189. 51p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

One method of demonstrating the stability of a power reactor is to impress the critical reactor with a sinusoidal oscillating reactivity and measure its power response as a function of frequency. The computer code FLUZ synthesizes such a test for oscillations of small amplitudes. The same technique may be used experimentally to measure different coefficients of reactivity of a given reactor. By varying the period of the impressed reactivity it is possible to change, owing to finite heat transfer times, the relative importance of various reactivity feedback mechanisms, such as the fuel Doppler effect or coolant density. FLUZ computes to the first order the amplitudes and phase angles of the oscillating power and feedback reactivity of a fast reactor which is oscillating about criticality due to an impressed sinusoidal reactivity of given amplitude and frequency. By varying this amplitude and frequency as well as the steady-state power, FLUZ can be used to simulate the power response of the reactor being studied to the magnitudes of various coefficients of reactivity. A comparison of the FLUZ results with experimental results from oscillation tests on the actual reactor can be used to reveal the magnitudes of the various reactivity coefficients. The

oscillating power in FLUZ is expressed in terms of the prompt and delayed components of the reactivity. Linear feedback reactivity is calculated using pre-determined coefficients of reactivity and computed time-dependent material temperatures. Average material temperatures are obtained for each of m axial regions, considering axial heat transfer to occur only by flow of the coolant. Heat transfer from fuel to coolant and structure is based upon an average coolant channel containing a cylindrical fuel rod with annuli of cladding and coolant. A flat radial power distribution across the fuel rod is assumed. (auth)

38125 (GEAP-4817) ACCURATE NUCLEAR FUEL BURNUP ANALYSIS. Thirteenth Quarterly Progress Report, December 1964–February 1965. Rider, B. F.; Ruiz, C. P., Peterson, J. P. Jr.; Seymour, R. S.; Jaech, J. L.; Smith, F. R. (General Electric Co., San Jose, Calif. Vallecitos Atomic Lab.). Mar. 1, 1965. Contract AT(04-3)-189. 35p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Calculation of burnup from U, Pu, and Nd mass spectrometric measurements was programmed for a digital computer. The program utilizes an iterative method to correct for the burnout and decay of the various species of interest. An interlaboratory comparison of standard lanthanide solutions was completed. No bias was found in the primary solutions used to calibrate neodymium spike solutions for isotopic dilution mass spectrometry. The rhenium filament material on hand was found to be high in natural barium content which interfered with barium and cerium mass analyses. By using the borax addition technique on tantalum filaments, the cerium analyses on irradiated ^{235}U, ^{233}U, and ^{239}Pu foils from capsules Bev-1 and -2 are proceeding smoothly. Measurements of relative fission yields from Bev-1 and -2 are nearing completion. (auth)

38126 (HW-84608(p.55-66)) SUMMARY OF RESULTS OF EBWR CRITICAL EXPERIMENTS. Schmid, L. C.; Lauby, J. H.; Stinson, W. P.; Uotinen, V. O. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Critical experiments are carried out in PRCF with fuel rods containing 1.5 wt. % PuO_2–UO_2 and with water moderator. The center-to-center lattice spacing of the rods in the experiments is 0.71 in., which corresponds to a volume moderator-to-fuel ratio of 2.71. This ratio is the same as will be used in EBWR with these fuel rods, although the geometry in EBWR will differ from that in PRCF. (T.F.H.)

38127 (HW-84608(p.77-9)) CRITICAL EXPERIMENTS WITH PuO_2–POLYSTYRENE COMPACTS. White, J. D.; Richey, C. R. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Critical experiments are carried out with PuO_2–polystyrene compacts at a H/Pu atomic ratio of 15 using a splittable device. The core material is composed of alternate 2-in. fuel cubes and 2-in. Plexiglas cubes. The core itself has a H/Pu atomic ratio of 35. Criticality characteristics are tabulated for the bare core and for various reflector and interface configurations and materials. (T.F.H.)

38128 (KFK-302) SUAK—A FAST SUBCRITICAL FACILITY FOR PULSED NEUTRON MEASUREMENTS. Borgwaldt, H.; Kuechle, M.; Mitzel, F.; Wattecamps, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik and Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). May 1965. 25p. (CONF-650504-39). Dep mn.

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Germany.

Four aspects of the fast subcritical facility SUAK for pulsed neutron measurements are presented. They are: description of the facility, theory underlying the pulsed neutron measurements, measurements of the neutron decay, and measurements of neutron spectra by the time-of-flight technique. (M.O.W.)

38129 (ORNL-P-748) ONE-VELOCITY MONTE CARLO CALCULATIONS OF URANIUM METAL CRITICAL GEOMETRIES. Mihalczo, J. T. (Oak Ridge National Lab., Tenn.). [Nov. 13, 1964]. Contract W-7405-eng-26. 7p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

A wide variety of unmoderated and unreflected critical experiments with geometrically complicated configurations of 93.2% ^{235}U enriched uranium metal are reported. Some of these experiments were analyzed by Monte Carlo methods with as detailed a treatment of the energy as the cross section information will allow. For calculations of multiplication constants only, however, a simpler one-velocity treatment is adequate, providing that the geometry is handled exactly. (M.O.W.)

38130 (ORNL-P-874) EXPERIENCE WITH UNUSUAL TECHNIQUES USED IN ORNL DEPLETION CODES. Vondy, D. R. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 3p. (CONF-650501-2). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From The Application of Computing Methods to Reactor Problems, Argonne, Ill.

Several of the reactor depletion codes contain some novel features which have proved useful either in accelerating the computations involved, or for improving their accuracy. Characteristics of these programs are given. (M.O.W.)

38131 (ORNL-P-1272) EXPERIENCE WITH UNUSUAL TECHNIQUES USED IN ORNL DEPLETION CODES. Vondy, D. R. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 17p. (CONF-650501-13) Dep.(mn); $1.00(cy), 1(mn) CFSTI

From The Application of Computing Methods to Reactor Problems, Argonne, Ill.

Unusual techniques used in core depletion codes are discussed. Results of representative calculations and effects of some of the approximations usually employed are examined. Special techniques were used to drive iterative procedures, and a form of direct integration was found practical to solve the neutron flux problem for a desired eigenvalue by necessary adjustment of nuclide concentrations. Use of a general, explicit calculation of nuclide concentrations with flux exposure has proven successful. In this, chain relations are specified as input data, and thereby control is exercised over the treatment used in each case. (M.O.W.)

38132 (ORNL-P-1287) RELEASE OF FISSION PRODUCTS FROM REACTOR FUELS DURING TRANSIENT ACCIDENTS SIMULATED IN TREAT. Parker, G. W.; Lorenz, R. A.; Wilhelm, J. G. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 41p. (CONF-650407-8) Dep. mn; CFSTI, $2.00 cy, $0.50 mn

From International Symposium on Fission Product Release and Transport Under Accident Conditions, Oak Ridge, Tenn.

Six experiments were conducted on the release of fission products from stainless steel- and Zircaloy-2-clad UO_2 fuel during a reactor transient. Argon, steam, and steam-air atmospheres were used, and the experiments covered both partial melting and non-melting of the UO_2. The fractions of fission products released and the reaction of steam with the cladding and fuel were determined. (D.L.C.)

38133 (STL-372-13) KINETIC STUDIES OF HETEROGENEOUS WATER REACTORS. Annual Summary Report, 1964. Molloy, C. T.; Neal, L. G.; Pate, N. C.; Wentz, L. B.; Wright, R. W. (TRW Space Technology Labs., Thompson Ramo Wooldridge Inc., Redondo Beach, Calif.). Dec. 30, 1964. Contract AT(04-3)-372. 142p. Dep. (mn); $4.00(cy), 3(mn) CFSTI.

Reactor safety research was conducted in three areas: transient steam formation in rapid power excursions, destructive pressures in reactor accidents, and boiling-water-reactor instability. Data are presented from in-pile capsule measurements of steam void formation and pressures in millisecond power transients. The water-filled capsule contained a uranium plate, which was heated by a burst of neutrons from the KEWB reactor. The transient pressures resulting from rapid heating of the fuel plate revealed what appeared to be a new phenomena, which limits energy transfer in subcooled transient boiling from a

surface near the thermodynamic critical temperature of the water. The SPERT-1D destructive transient was analyzed from an energy standpoint. The reactor power trace indicated that the reactor was in a shutdown condition at the time of the destructive pressure impulse, and that considerable reactivity was compensated. A related series of experiments were carried out in an electrically heated pressure generation experiment. A laboratory capsule was filled with water and sealed, and a rapid heating transient was imposed on the test element. A temperature rise of 700°C occurred in about 0.1 msec. Pressures of only about 1000 psi were obtained. To study the effects of pre-existing voids on pressure generation, an air bubble was introduced into the closed capsule with the void volume per unit heat transfer area the same as that estimated for the molten dispersed SPERT-1D core. Pressure generation was greatly reduced by the presence of void. Maximum pressures of about 600 psi were observed. The hydrodynamic stability of a 16-rod bundle at atmospheric pressures was studied. Instabilities were found to arise rather gradually as power increased. Some two-phase slip velocity models including distributional effects are summarized. (M.C.G.)

38134 (WAPD-T-1792) REACTOR-PLANT DYNAMICS DURING LOSS OF COOLANT. Redfield, J. A.; Margolis, S. G. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1965. Contract AT(11-1)-Gen-14. 11p. (CONF-650602-34). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

A model is described which is able to calculate the consequences of the loss of coolant accident for water-cooled reactors. Previous assumptions usually made in describing a model of this type are ignored. This model was used to predict the characteristics of a planned loss of coolant transient in the experimental facility LOFT. The results of this test are reported. (M.O.W.)

38135 EFFECTS OF DELAYED NEUTRONS ON ESTABLISHING A STEADY FISSION CHAIN. Kolesov, V. F. At. Energ. (USSR), 18: 578-83(June 1965).

Stochastic process of delayed neutron multiplication in a limited fission chain in a prompt supercritical reactor was investigated. Formulas were derived for the distribution momenta of a certain number of precursors of delayed neutrons and for the mean square deviation. The influence of delayed neutrons on the time of establishing the first steady fission chain was studied. Equations and data of their approximate solutions were compiled. It was found that at small reactivity and weak source the mean time for establishing a steady fission chain can be reduced by the delayed neutrons 10 fold or more. (R.V.J.)

38136 A NEW METHOD FOR RECOVERING TRUE SPECTRA. Tikhonov, A. N.; Arsenin, V. Ya.; Dumova, A. N.; Maiorov, L. V.; Mostovoi, V. I. At. Energ. (USSR), 18: 588-92(June 1965).

A new method was suggested for resolving integral equations of the first type used for recovering the true spectra distorted by a measuring instrument. Recovery of the true energy spectra of epithermal neutrons in uranium reactor blocks measured by means of a mechanical selector and calculations of scalar energy flux of thermal neutrons in a uranium-water lattice measured by means of a directed flux are investigated as examples illustrating the correction techniques for problems in reactor physics. (R.V.J.)

38137 THE COMPENSATION OF REACTIVITY BY MEANS OF ABSORBING RODS. Valenta, Vaclav; Vlachovsky, Karel. Jaderna Energie, 11: 166-70(May 1965). (In Czech).

A new possibility is demonstrated for reactivity compensation by means of horizontal absorbing grates (grid rods) placed between vertical fuel channels. A two-group calculation was carried out for a reactor without a reflector. The physical characteristics are reported for systems of two and four symmetrically placed, and one or two unsymmetrically placed control grates (grids) in relation to their position, and to the absorption and scattering properties of the medium. Results indicated that this reactivity compensation method is advantageous for heavy-water reactors. (auth)

38138 TECHNIQUE FOR OPTIMIZING THE COMPOSITION OF REGENERATING-NEUTRON-FLUX MONITORS. Bunch, W. L. (General Electric Co., Richland, Wash.). Nucl. Appl., 1: 259-66(June 1965).

Regenerating detectors incorporate fertile material along with fissile material to sustain the sensitivity of neutron monitors located in high-flux environments. A mathematical model for optimizing the initial composition of the regenerating material was formulated and programmed. An experimental evaluation, based on mass-spectrometric determinations of the change in isotopic composition as a function of neutron exposure, was completed using plutonium isotopes. The agreement between experiment and calculations was within uncertainty introduced by basic cross-section data. (auth)

38139 ABOUT THE INFLUENCE OF RESONANCE OVERLAPPING ON CALCULATED DOPPLER-COEFFICIENTS OF FAST REACTORS. Froelich, R.; Ott, K. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng., 22: 490-2(1965).

The splittings into contributions of different isotopes to the total Doppler reactivity coefficient of a reactor are studied. The splitting based on effective cross sections is treated first with the result that the overlap effect does not influence the contributions of different isotopes. The splitting based on ratios of reaction rates is then treated; a strong overlap influence on the contributions of different isotopes is noted. The two treatments result in the same Doppler reactivity coefficient for a reactor. (D.C.W.)

38140 PERTURBATION THEORY OF CONTROL RODS. Spinks, N. (Australian Atomic Energy Commission, Sutherland, New South Wales, Australia). Nucl. Sci. Eng., 22: 504-5(1965).

The calculation of the reactivity worth of control rods by the perturbation methods of Wolfe and Fischer is considered. It is concluded that, although the first-order perturbation theory of Wolfe and Fischer is valuable for predicting the worth of control rods in reactors where $\tau \gg L^2$, the second-order theory can produce inaccurate results, particularly for reactors where $\tau \gg L^2$. For reactors where τ is not much greater than L^2, the use of the theory to any order does not appear to be justifiable. (D.C.W.)

38141 CRITICAL MASS MEASUREMENTS FOR VARIOUS FUEL CONFIGURATIONS IN THE LASL D_2O REFLECTED CAVITY REACTOR. Jarvis, George A.; Byers, Cleo C. (Los Alamos Scientific Lab., N. Mex.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint AIAA Paper No. 65-555, 14p. $1.00. (CONF-650610-2). ORINS

From American Inst. of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs.

The gaseous core cavity reactor is receiving continuing study as a possible basis for advanced performance nuclear propulsion systems. For this reason the Los Alamos Scientific Laboratory is operating a small cavity reactor, on a low priority basis, to accumulate information on some of the more important parameters for this type of reactor system. The LASL cavity reactor consists of a cylindrical cavity 40 inches in diameter and 40 inches in length, surrounded by a 20 inch thick D_2O reflector. For the initial fuel loading, 93.1 ^{235}U metal foils lined the surface of the cavity. The critical mass for this configuration was 5.7 kilograms of enriched uranium. Heating of the reflector results in increased critical mass. The reflector D_2O was heated through a range of about 40 degrees centigrade above room temperature. Critical mass as a function of reflector temperature is given. Measurements to examine consequences of a gaseous fuel shift were made. The fuel penalty as a function of orifice diameter is also given. (J.F.P.)

38142 METHOD FOR OPERATION OF A NUCLEAR REACTOR AND NUCLEAR REACTOR FOR CARRYING OUT THIS METHOD. Fishman, Ygal (to Gebrueder Sulzer AG). German Patent 1,191,919. Apr. 29, 1965. Priority date June 7, 1962, Switzerland.

Control of a reactor by adjustment of the speed of circulation of the coolant in response to the exit temperature of the coolant and in relation to the neutron flux in the reactor is discussed. (Gmelin Inst.)

Design and Feasibility

38143 NUCLEAR REACTOR CORE STRUCTURE. Potter, Ronald (to United Kingdom Atomic Energy Authority). U. S. Patent 3,175,954. Mar. 30, 1965. Priority date July 5, 1962, Great Britain.

In a nuclear reactor elongated fuel element assemblies are clustered on respective parallel axes to form a generally cylindrical reactive core configuration. Spaced parallel tubes define channels separately housing the individual fuel assemblies. First connecting means between neighboring channel defining tubes establish a first set of flow paths for causing the fluid moderator flowing in the channels to pass sequentially over fuel element assemblies lying on chords of the cylindrical core configuration. Second connecting means between other neighboring tubes establish a second set of flow paths for the moderator. Chords of the second set of paths are in parallel relationship but intersect the chords for the first set of paths. A matrix of flow paths are formed in this manner so that excess heat generated at a locality in the core is dissipated over the whole core area. (B.L.M.)

38144 BOILING WATER NUCLEAR REACTOR. Hackney, Stanley (to United Kingdom Atomic Energy Authority). U. S. Patent 3,184,391. May 18, 1965. Priority date June 9, 1960, Great Britain.

In a reactor for evaporating a water coolant and having a heat-producing core including fuel elements, a liquid neutron-moderating heat transfer medium is present as an intermediary between the fuel elements and the coolant at a pressure to prevent boiling. It is contained separately from, but in heat transfer relationship with, the coolant in a circuit surrounded throughout by the coolant. Preferably a pump is used to circulate the heat transfer medium. The medium may be water of the same quality as the coolant or it may be heavy water or an organic compound. A..y radioactivity resulting from a fuel-element defect occurs in the heat transfer medium, and the coolant is not contaminated. Therefore, enclosure of the coolant circuit in a containment vessel is unnecessary. (A.G.W.)

38145 CONTINUOUSLY REFUELED NUCLEAR REACTORS. Mangieri, John B.; Hall, Perry; Hunter, Jack A. (to Martin-Marietta Corp.). U. S. Patent 3,190,806. June 22, 1965. Filed Oct. 9, 1962.

The reactor patented is constructed to contain a number of separate fuel bundles, which are received into the active lattice through an inlet port, moved along a continuous track through the core of the reactor, and removed as spent fuel bundles through an exit port. Preferably the continuous track is spiral with the inlet port near the outside wall and the exit port near the center of the reactor. Insertion and removal of fuel bundles is accomplished without relieving the pressure in the pressure vessel by means of vertical cylindrical pressure locks. Shutdown for refueling is thus eliminated and uniform burnup of fuel elements is obtained. (A.G.W.)

38146 PRESSURE TUBE REACTOR. Bevilacqua, Frank (to Combustion Engineering, Inc.). U. S. Patent 3,190,807. June 22, 1965. Filed Sept. 7, 1960.

The pressure tubes in the reactor patented are arranged in horizontal planes, which are in juxtaposed vertically spaced relation throughout the height of the moderator tank. The tubes in a single plane are parallel, with the tubes in adjacent planes or adjacent pairs of planes being disposed crosswise to each other, thereby providing a cross-latticed arrangement. The divergently directed tubes terminate in locations remote from each other and thus alleviate congestion in providing connections and access to the tube ends. The arrangement is suitable for use with graphite and D_2O moderators. (A.G.W.)

Fuels

Refer also to abstract 36217.

38147 TRANSIENT TEMPERATURE DISTRIBUTIONS IN END CAPS OF PLATE FUEL ELEMENTS. Ma, Benjamin M. (Iowa State Univ., Ames). Nucl. Struct. Eng., 2: 48-54(July 1965).

The transient temperature distribution in bonded end caps of plate-type fuel elements submitted to sudden temperature change resulting from unsteady-state reactor operation was analytically determined. The solution for the temperature distribution is represented by products of circular function, exponential functions, and coupling relations between the end caps and the fuel material of the fuel elements. A numerical example was developed for a ceramic dispersion fuel element with zircaloy end caps. For a given end-cap material, the temperature distribution for end caps of various depths (or thicknesses) was the same, if the time of heat conduction was proportional to the square of the depth. The temperature distribution in the end cap decreased with increasing end-cap length and Fourier number. Repeated sudden temperature changes, which induced severe thermal shock, cycling, fatigue, and temperature excess, could seriously affect the corrosion rates and impair the structural integrity of the end caps as well as the fuel elements. The corrosion temperature limit and thermal fatigue of the end cap (or cap of a fuel can) could be much more serious than that of the fuel material. (auth)

38148 THEORETICAL AND EXPERIMENTAL STUDIES ON THE STRESSES AND STRAINS IN CLADDINGS OF ANNULAR BOILING-SUPERHEAT FUEL ELEMENTS. Schwarzwaelder, R.; Wolf, O. (AEG, Frankfurt am Main). Nucl. Struct. Eng., 2: 55-84(July 1965).

The high-temperature difference between exterior and interior cladding is an annular combined boiling-superheat fuel element results in considerable axial stresses and strains in both claddings during reactor operation. Each startup or shutdown of the superheat reactor causes cyclic changes of these stresses and strains. The equations necessary to predict the behavior of boiling-superheat fuel elements were deduced and the calculated stresses are given for several examples with various cladding materials. Results of experimental studies with boiling-superheat fuel elements in an out-pile thermal cycling test facility are given. Full size fuel element specimens were subjected to up to 800 severe thermal cycles. The observations made, including some defects which occurred, are discussed. The results were critically reviewed and compared with the analyses. Even considering the fact that the mechanical properties of cladding materials of interest under irradiation at high temperature are not very well known it was concluded that the axial stresses and strains in a boiling-superheat fuel element do not present an unsurmountable problem in the development of this type of fuel elements. (auth)

38149 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Mann, Charles Alan; Rooney, John; Berry, Peter Francis; Cameron, John Foster (to United Kingdom Atomic Energy Authority). British Patent 989,392. Apr. 14, 1965. Filed Nov. 20, 1962.

A sheathed fuel element design is described that incorporates a leak detection system in its fabrication. The fuel element has a reservoir volume of free space at a selected position, preferably at each end, within the protective sheath. The total free volume space is more concentrated at the selected positions than elsewhere within the sheath. During the manufacture of the element, this free space is

filled with an otherwise uncontaminated gas containing a radioactive tracer so that before operation of the element in the reactor a concentration of the radioactive gas becomes concentrated within the selected positions. A radioactivity detector is applied to the element in the proximity of the reservoirs and at a position well removed from the reservoir. A subtraction of the two count readings and a comparison of this difference with the count calculated from the natural decay rate of the tracer and the period that has elapsed between the introduction of the filling gas into the fuel element and the application of the test demonstrates the occurrence or absence of leaks. (B.L.M.)

38150 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Mann, Charles Alan; Rooney, John (to United Kingdom Atomic Energy Authority). British Patent 989,393. Apr. 14, 1965. Filed Nov. 20, 1962.

A method is described of introducing an inert gas into the sheath of a reactor fuel element of the kind that includes a member(s) of fuel material enclosed in a protective sheath. The method includes placing a predetermined quantity of a clathrate compound (an inclusion-type compound in which a molecule of one component is completely enclosed by a molecule(s) of a second component in such a way that the escape of the first component is normally prevented) formed of radioactive Kr-85 and quinol into the sheath prior to sealing the sheath. After sealing the sheath, the element is heated to release the inert gas from the clathrate compound. The clathrate compound may be associated with a component of the fuel element by being incorporated in the pores or in a recess of a component, or the compound may be fashioned into a member that is interposed between the end cap closing one end of the sheath and the fuel material. (B.L.M.)

38151 DEVICE FOR THE TRANSMISSION OF AN ELECTRIC POTENTIAL DIFFERENCE BETWEEN TWO SUCCESSIVE FUEL ELEMENTS STACKED IN A CHANNEL OF A NUCLEAR REACTOR. Liermann, Jean (to Commissariat a l'Energie Atomique). German Patent 1,194,073. June 3, 1965. Priority date Apr. 10, 1962, France.

On the end plug of each cartridge is disposed a fixed central contact stud and a peripheral stud supported by the upper edge of a resilient annular cup, which is slightly curved and substantially equal in diameter to the plug. The cup is fixed to the plug concentrically with the central stud, in such a manner that in the absence of stress the peripheral stud projects beyond the apparent contour of the remainder of the cartridge. (Gmelin Inst.)

38152 THERMAL EXCHANGE OF THE FUEL ELEMENTS IN NUCLEAR REACTOR. Le Foll, Jean (to Commissariat à l'Énergie Atomique). U. S. Patent 3,179,570. Apr. 20, 1965. Priority date Aug. 13, 1959, France.

Transverse fins are provided on the body of a fuel element to increase the thermal exchange. The thickness of the fins and the interval between them is made as small as present manufacturing techniques permit. The height of the fins is about 3–10 times the separation between them. The cooling fluid is made to circulate transversely through the unitary circular channels formed by the fins. A number of spaced deflecting elements are uniformly distributed over the fins for deflecting the fluid into the circular channels. Each of the deflecting elements is triangular with one side tangent to the edges of the fins, lies in a single plane oblique to the axis of the fuel element, and forms arrow-shaped flat vanes. Longitudinal backbones parallel to the longitudinal axis of the element secured to and in contact with the outer edges of the fins support the deflecting elements. (B.L.M.)

38153 NUCLEAR FUEL UNITS WITH ENCLOSURES OF THE THIMBLE TYPE FOR PRESSURE-TUBE NUCLEAR REACTORS. Schabert, Han-Peter; Michael, Horst (to Siemens-Schuckertwerke Aktiengesellschaft). U. S. Patent 3,179,571. Apr. 20, 1965. Priority date Nov. 3, 1960, Germany.

A nuclear fuel unit for pressure-tube reactors includes an outer tube closed at the bottom and an inner tube extending from a location spaced from the bottom of the outer tube upwardly in coaxial relation to the outer tube and forming an annular space in the lower portion of the outer tube. A number of parallel columns of fuel elements are located in the annular space around the inner tube, and the elements are spaced from each other and radially spaced from the inner tube to form passages for the coolant. The elements in any one column have a larger diameter closest to the inner tube with the diameter decreasing radially from the inner tube. The upper portion of the outer tube is at least as long as the axial length of the columns. The inner tube has a flange at its upper end extending across the outer tube forming a partition above the column of fuel elements and sealing the annular space from the upper portion of the outer tube. A cylindrical shielding plug is located in the upper portion above the flange. The plug has a smaller diameter than the outer tube and forms an annular space above the flange with the outer tube. Coolant supply means are arranged near the top of the outer tube and communicate with the inner tube through the annular gap. Coolant outlet means are located below the flange and communicate with the annular space above the columns. The cover, plug, extension, flange, and inner tube are all joined together and can be removed from the outer tube. (B.L.M.)

38154 FUEL ELEMENTS FOR USE IN NUCLEAR REACTORS. Perilhou, Jean; Le Gargasson, Georges (to North American Philips Co., Inc.). U. S. Patent 3,179,572. Apr. 20, 1965. Priority date Apr. 4, 1960, France.

A sheathed type fuel element is made up of rings of fissile material supported on a mandrel out of contact with the sheath with a supporting nut for the mandrel and an intermediate adjustment ring. A coating composed of perforated graphite or tungsten is spaced from and surrounds the fissile material. The coating and central support are rigidly secured together. (B.L.M.)

38155 FAST NUCLEAR REACTOR FUEL ELEMENTS. Blake, Leslie Reginald (to United Kingdom Atomic Energy Authority). U. S. Patent 3,184,392. May 18, 1965. Priority date Aug. 17, 1959, Great Britain.

A reactor fuel element designed for high burnup has a generally cylindrical sheath of high tensile strength and high creep strength so as to be capable of withstanding an internal pressure of at least 10,000 psi at a temperature of 600°C. Fuel occupies 70–90% of the volume of the sheath, the unoccupied volume serving as expansion space for the fuel and for accommodation of fission products. Several arrangements of fuel and void space are suggested. (A.G.W.)

38156 FUEL ELEMENT FOR ATOMIC REACTORS. Blomeyer, Walter; Schneider, Guenther (to Nukem Nuklear-Chemie und -Metallurgie GmbH). U. S. Patent 3,184,393. May 18, 1965. Priority date Nov. 4, 1960, Germany.

A reactor fuel element consists of a fuel body of U or U alloy, an Al can, a Ni solder layer bonded to the body, a second Ni solder layer bonded to the can, and a layer of Cr between the Ni layers and bonded to both. A layer of Cu may be added between the second Ni layer and the can. The layers can be applied as galvanic precipitates in a vacuum. The Al can is then applied at 600°C under a pressure of 80 atm. (A.G.W.)

38157 NUCLEAR REACTOR FUEL ELEMENTS. Blake, Leslie Reginald (to United Kingdom Atomic Energy Authority). U. S. Patent 3,189,101. June 15, 1965. Priority date Mar. 28, 1961, Great Britain.

A metallically sheathed fuel element for a nuclear reactor contains an integral length of nuclear fuel in direct and intimate contact over its outer periphery with the sheath. The length of fuel is slotted from its outer periphery to a depth reaching to the center of the fuel section throughout its length, and the opposing walls of the slot are spaced apart to allow for elastic radial deformation of the section of nuclear fuel. The void resulting from the slot is filled with a gas inert to the fuel. (A.G.W.)

38158 FUEL ELEMENT ASSEMBLY. Hoecker, Karl H.; Wagner, Friedrich (to Siemens-Schuckertwerke AG). U. S. Patent 3,189,524. June 15, 1965. Priority date July 12, 1958, Germany.

A fuel assembly is designed for a reactor system to be cooled at least primarily by thermal radiation. Elongated bodies of high-melting thermostable nuclear fuel are mounted in tubes without engaging the walls of the tubes. The fuel bodies are supported in spaced relation to the inner wall of the tube and in transversely spaced relation to each other by blocks of moderator material spaced along the length of the tube. The tubes containing the fuel elements are provided with gas-tight plugs at the ends and are either evacuated or filled with inert gas. The tube is enclosed in an outer tube through which flows a working medium, preferably CO_2 or liquid metal. (A.G.W.)

38159 NUCLEAR REACTOR FUEL ELEMENTS. Davis, Michael (to United Kingdom Atomic Energy Authority). U. S. Patent 3,189,525. June 15, 1965. Priority date Apr. 19, 1960, Great Britain.

Elongated fuel elements designed to be stacked end to end in a reactor fuel channel are provided with a laterally projecting portion extending part way around the periphery of the element and having a surface inclined to the longitudinal axis of the fuel element. When the fuel element is in place in the reactor, coolant flow against the surface moves a part of the fuel element into contact with the wall and stabilizes the element against vibration in the channel. The surface is spaced apart from the element and secured to it by one or more webs to permit coolant flow. (A.G.W.)

38160 THERMOELECTRIC NUCLEAR FUEL ELEMENT. McPartland, James O.; Pember, Linden A.; Christensen, James A. (to U. S. Atomic Energy Commission). U. S. Patent 3,198,711. Aug. 3, 1965.

A fuel element is designed which develops thermoelectric power. It includes a hollow cylinder of sintered ceramic fuel, compacted ceramic fuel powder having a coil of metal embedded therein in the opening in the hollow cylinder, a jacket surrounding the hollow cylinder, compacted ceramic fuel powder having a wire grid embedded therein in the space between the hollow cylinder and the jacket, and electrical connections to the metal coil and metal grid. (AEC)

38161 HIGH TEMPERATURE NIOBIUM-UO_2 NUCLEAR FUEL SHEET. Kling, H. P.; Sama, L.; Priceman, S.; Brodwin, B.; Eiss, A. L. (to U. S. Atomic Energy Commission). U. S. Patent 3,202,585. Aug. 24, 1965.

A high temperature ribbon type nuclear fuel element and a method for making the same are described. The element has a core of enriched UO_2 in a matrix of a metal selected from the group consisting of niobium, niobium–molybdenum, and niobium–molybdenum–titanium. The core is protected by an intermediate layer of a niobium–titanium alloy and an outer layer of aluminum or an aluminum–silicon alloy. (AEC)

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Refer also to abstracts 36700 and 36961.

38162 (AQNP-63580) LARGE FAST REACTOR DESIGN STUDY MONTHLY REPORT, JULY 1963. (Allis-Chalmers Mfg. Co., Washington, D. C. Nuclear Power Dept.). Contract AT(11-1)-1316. 7p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

Design criteria were established for a large fast reactor. Complete reliance on the Doppler coefficient for reactor safety was to be avoided. No large positive reactivity coefficient for fuel movement was permitted. The fuel was designed for high burnup. Stainless steel-clad UO_2-PuO_2 fuel is to be used. Mechanical and thermal-hydraulic analyses are discussed. Preliminary analysis to determine the sodium void coefficient for large cores was started. (M.C.G.)

38163 (ACNP-64604) LA CROSSE BOILING-WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Technical Report No. 5, April–June 1964. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Aug. 1964. Contract AT(11-1)-654. 55p. (DOCKET-115-5). Dep.(mn); $2.00(cy), 2(mn) CFSTI.

The development of failed-fuel-element detectors and control-rod drive mechanisms for the La Crosse BWR are reviewed. The dynamics of this reactor are analyzed. (T.F.H.)

38164 (ACNP-64628) LA CROSSE BOILING-WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Technical Report No. 6, July–September 1964. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Nov. 1964. 65p. (DOCKET-111-5). Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The development of the failed-fuel-element location system and the control-rod-drive mechanism for the La Crosse Power Reactor are reviewed. Dynamic analyses and in-core flux monitoring studies are also reported. (T.F.H.)

38165 (ACNP-65531) PATHFINDER ATOMIC POWER PLANT TECHNICAL PROGRESS REPORT, APRIL 1964–JUNE 1964. (Allis-Chalmers Mfg. Co., Milwaukee, Wis. Atomic Energy Div.). Apr. 20, 1965. Contract AT(11-1)-589. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Test 301 (boiler slab core loading and criticality) was completed. The test determined the minimum critical number of reference 2.2 wt % ^{235}U-enriched fuel assemblies in a rectangular slab array. In addition, information was obtained on the reactivity worth of additional boiler fuel assemblies. Pre-experiment analytical results were obtained for test 302(full boiler core loading and criticality). Initial criticality was obtained with 15 fuel elements in a 3×5 slab array, compared with a predicted 13 fuel elements. This represented a calculated loss in core reactivity of 1.3%. Areas of uncertainty in the model used for calculation include the homogenization of axial gap regions, the zirconium resonance integral, multigroup calculations, and homogenization of fuel-rod region, Zr box, and control rod channels. (M.C.G.)

38166 (ACNP-65533) ANALYSIS OF CLUSTERED-PIN SUPERHEATER LATTICE EXPERIMENTS. Lacy, P. S.; Lewellen, J. W. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Apr. 30, 1965. Contract AT(11-1)-589. 37p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A variety of clustered-pin superheater test cells designed for use in Pathfinder are irradiated in a critical facility. Experimental values and computer analyses are given of the fission rates, thermal fission rates, resonance integrals, and thermal utilization values. (T.F.H.)

38167 (AECL-2214) THE PICKERING NUCLEAR GENERATING STATION. Beynon, C. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1965. 10p. (CONF-650515-11). Dep.; AECL, $1.00 cy.

From International Conference and Exhibition of Canadian Nuclear Assn., Quebec.

Plant layout, buildings, design parameters, fuel handling and control systems for the two 500 MWe units at the proposed Pickering Nuclear Generating Station are described. The site is laid out for an eventual plant having eight units. Target date for full power operation is 1970. (F.S.A.)

38168 (AECL-2220) THE DEVELOPING ROLE OF ORGANIC COOLANTS IN NUCLEAR POWER REACTORS. Brown, W. M. (Canadian General Electric Co., Ltd., Peterborough (Ontario)). Mar. 24, 1965. 21p. Dep.; $1.00(AECL).

The development of organic coolants for use in the CANDU type reactor is discussed. Included is an outline of the advantages and disadvantages of present organic coolants and the current development programs. The

WR-1 reactor at Whiteshell is described and illustrated. (auth)

38169 (AEEW-M-453) A METHOD FOR COMPARISON OF EXPERIMENTAL AND THEORETICAL DIFFERENTIAL NEUTRON SPECTRA IN THE ZENITH REACTOR. Reed, D. L.; Symons, C. R. (Atomic Energy Establishment, Winfrith (England)). Jan. 1965. 34p. Dep.; BIS, $0.90; HMSO, 4s. 6d.

A method of calculation is given which assists the analyses of chopper measurements of spectra from ZENITH and enables complex multigroup theoretical calculations of the spectra to be put into a form which may be compared with experiment. In addition the theory of the cut-off function was extended to give analytical expressions which take into account the effects of sub-collimators, off center slits and of a rotor made of a material partially transparent to neutrons. The theoretical cut-off function suggested shows good agreement with experiment. (auth)

38170 (AFOSR-65-0315) CASCADE ARRANGEMENT IN SPHERICAL VESSEL DESIGN FOR NUCLEAR POWER REACTORS. Hu, L. W.; Schutzler, J. (Pennsylvania State Univ., University Park. Dept. of Engineering Mechanics). Jan. 1965. 29p.

Pressure vessels in cascade arrangement are suggested for nuclear power reactor design. The stress analysis and a procedure for the minimum weight design of cascade spherical shells are presented. A numerical example of two stage spherical shells is given to demonstrate the procedures developed as well as the need of such type of pressure vessels in nuclear power reactor design. (auth)

38171 (APDA-158(Suppl.)) COST ESTIMATE FOR FAST FUEL TEST FACILITY (EOCR MODIFICATIONS). De Felice, J.; Edwards, J. J.; Jens, W. H.; Poggi, R.; Ross, T. P.; Warberg, H. S.; Lomuller, V. (Atomic Power Development Associates, Inc., Detroit, Mich.). Feb. 29, 1964. Contract AT(11-1)-865. 36p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A summary of the capital costs operating costs is listed in tables. The capital costs are $2,836,000 excluding contingencies. Due to the preliminary nature of this cost estimate, a high contingency of 40 per cent was used. Thus, the capital costs including contingencies are $3,966,000. The contingency is probably on the high side, and should be re-evaluated during design. The total annual operating costs for the EOCR and the test loop are $2,680,000. The operating costs are based for the most part on information supplied by the Phillips Petroleum Company. The cost estimate for the initial fuel loading is based on using approximately 3000 fuel plates presently fabricated. (auth)

38172 (APED-4784) DESIGN AND OPERATING EXPERIENCE OF THE ESADA VALLECITOS EXPERIMENTAL SUPERHEAT REACTOR (EVESR). Ianni, P. W.; Fritz, J. R.; Law, D. D. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb. 1965. 63p. (65APE2)

The description of the ESADA Vallecitos Experimental Superheat Reactor is given. Detailed information on fuel bundle assemblies, reactor thermal hydraulics, emergency cooling system, pressure vessel, and operating experience of the EVESR is presented. (M.O.W.)

38173 (CONF-650602-28) URANIUM OXIDE TUBES FOR HEAVY-WATER POWER REACTORS. Projected Economics and Reactor Performance. Hood, R. R. (Du Pont de Nemours (E.I.) and Co., Wilmington, Del.). June 15, 1965. Contract AT(07-2)-1. 41p. Dep.(mn), $2.00(cy), 1(mn) CFSTI.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

The advantages of uranium oxide tubes compared to clusters of oxide rods are pointed out. A summary is presented of results of the oxide tube development, which included: conceptual design studies, development of fabrication process, irradiation studies in the HWCTR, and cost evaluations. The use of oxide tubes in organic-cooled reactor is considered briefly. (D.L.C.)

38174 (GA-6367) THE USE OF LOW-ENRICHMENT URANIUM AND PLUTONIUM IN THE HTGR. Jaye, S.; Fischer, P. U.; Lee, D. H. Jr. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). May 7, 1965. Contract AT(04-3)-167. 29p. (CONF-650606-7) Dep.(mn); $2.00(cy), 1(mn) CFSTI

From EURATOM Symposium on Fuel Cycles of High-Temperature Gas-Cooled Reactors, Brussels.

The HTGR concept yields attractive fuel cycle costs on either the low-enrichment uranium fuel cycle or the thorium fuel cycle with plutonium makeup. The standard thorium fuel cycle using fully enriched uranium makeup exhibits costs from 0.1 to 0.2 mill/kw-hr lower than these fuel cycles. However, the difference could be reduced by a change in the economic parameters or could be accepted because of the availability of low-enrichment uranium or plutonium. Thus, the reactor operator has the flexibility to use any of three fuel cycles depending on the prevailing conditions. The uranium resources required for the HTGR complexes are modest and comparable with reactor complexes based on the fast breeder. For a nuclear capacity expanding with the rapidity of that projected by the EURATOM Commission, the resources are primarily dependent on the specific power rather than the conversion ratio. The flexibility of operation available in the HTGR makes it possible to obtain a high specific power during this period of rapid expansion and, subsequently, to operate with a higher conversion ratio as the capacity doubling time stretches out. (auth)

38175 (GEAP-4445) A SURVEY OF WATER REACTOR PRIMARY SYSTEM CONDITIONS PERTINENT TO THE STUDY OF PIPE RUPTURE. Kilsby, E. R. Jr., (comp.) (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1964. Contract AT(04-3)-189. 108p. Dep. mn; CFSTI, $3.00 cy, $0.75 mn.

As part of the investigation of piping reliability in water-cooled reactor systems, a survey of the nuclear industry was conducted to establish the range of parameters which should be considered in a study of piping rupture. The survey results are summarized and discussed. (D.L.C.)

38176 (GEAP-4578) MECHANICAL DESIGN CONSIDERATIONS IN PRIMARY NUCLEAR PIPING. Tagart, S. W. Jr. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar. 1964. Contract AT(04-3)-189. 128p. Dep. mn; CFSTI, $4.00 cy, $1.00 mn.

A summary is presented of work conducted in the Stress Analysis and Design Criteria phases of the AEC Reactor Primary Coolant Pipe Rupture Study. Methods for mechanical design and reliability evaluation of nuclear piping are reviewed and assessed. Special problem areas are discussed. A general elastic shell analysis is given. (D.L.C.)

38177 (GEAP-4780) EVESR TRANSIENT MODEL. Maxwell, D. C. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb. 1, 1965. Contract AT(04-3)-189. 65p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The equations required for a transient representation of a superheat reactor such as EVESR are derived. The numerical values for EVESR are also included. (auth)

38178 (GEAP-4790) NUCLEAR SUPERHEAT PROJECT TWENTY-SECOND QUARTERLY REPORT, NOVEMBER 1964–JANUARY 1965. Flock, W. L. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb. 1965. Contract AT(04-3)-189. 163p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

The SC-9 capsule in the GETR has continued to perform satisfactorily through three of five cycles. Data from the 2500-hour tensile test for Inconel-625, Incoloy-801, and Incoloy-825 was obtained for thermal aging temperatures of 1000, 1100, 1200, and 1300°F, and test temperatures of 75, 1100, and 1300°F. All three alloys had high strength and good ductility at the conditions tested. An out-of-core test facility is being designed to evaluate the effect of biaxial, high-temperature creep on fracture characteristics of alloys for superheat clad. Work is proceeding on the investigation of factors producing loss in high-temperature ductility after exposure to neutron irradiations. Work is

proceeding on the preparation of small ingots of B-free Incoloy-800 by electron-beam melting techniques. These ingots will be used as parent melts for doping with B having different isotopic ratios. A capsule was designed to permit irradiation of tensile coupons in the EBR-II. The objective of this experiment is to evaluate the embrittling effect of transmutation reactions in a fast spectrum. Results of examination of Incoloy-800 sheaths exposed in the No. 3, 4, and 5 heater positions of CL-1 similar results to those reported previously. Corrosion with heat transfer data was obtained for Inconel-625 at 800 to 1410°F and exposures to 600 hours. The descaled weight losses are less than for Incoloy-800, however, the metal-to-system loss appears to be about the same. The 10,000-hour corrosion data at 1150°F is available for Incoloy-800, Inconel-600, Type 304 stainless steel, Hastelloy-X, Incoloy-825, and Type 406 stainless steel. This data was the basis for lowering of the calculated corrosion rate for all materials except Type 406 stainless steel, which showed no change. Type 304 stainless steel and Inconel-600 have corrosion rates substantially higher than the other materials tested. Evaluation of isothermal corrosion of annealed versus cold worked Incoloy-800 is continuing. Hf wire exposed to 932°F steam for 1000 hours had a weight gain of 40 mg/dm^2. X-ray fluorescence and x-ray defraction techniques were used to identify material in the corrosion layer of several alloys. Tests were initiated to establish the effect on corrosion of surface preparation, geometry, steam velocity, and heat transfer. Results of the first 1000 hours indicate that there may be significant differences due to these variables. Measurements were completed for multi-rod geometry with smooth tubes. Heat transfer and flow friction data were established for several pitch-to-diameter ratios. The ESH-3A fuel bundle was assembled and is stored in the RML pool awaiting insertion into EVESR. The data package for this element has been completed. The ESH-4 test report is included. Additional measurements were made with the Doppler furnaces to evaluate perturbations created by structural components of the furnaces and the importance of self-shielding of the foils. The results indicated a very weak dependence on the amount of Ni scattering material. The measurement of the flooding-poisoning effect was extended to 16 bundles. The results indicate that the flooding effect is very sensitive to the surface-to-mass ratio of the flooded-poisoned zone, and that extrapolation of the few bundle experiments leads to overestimation of the amount of poison required. Calculations on the worth of materials in the fast core were made and compared with measured values for Inconel and stainless steel. These results indicate that the worth of Ni is not being accounted for correctly. A two-dimensional calculation matching the present MSCA critical loading (23% enriched fast core and 316 equivalent thermal core assemblies) is used to approximate the MSCA geometry better. This computation, performed with the PDQ code using four energy groups in the R-Z geometry, gave a calculated power split of 0.30/0.70 compared with 0.32/0.68 (fast core/thermal core). The k_{eff} is about 3% high for both cores. (J.R.D.)

38179 (NAA-SR-Memo-3830) SODIUM-24 SPECIFIC ACTIVITY IN HNPF U–Mo AND U–C REACTOR SYSTEMS. Spiegler, P. (Atomics International, Canoga Park, Calif.). May 21, 1959. Contract AT-11-1-GEN-8. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The specific activity of the primary sodium in the HNPF is determined for six possible core configurations (3 U–Mo and 3 U–C). The analysis was performed using a neutron economy method. Since this method of calculating the specific activity is different from that previously used it was first applied to the SRE and the resultant sodium activity compared with available experimental data. Agreement with experiment was good and the method was therefore applied to the HNPF cores. The results of the calculations are summarized. (auth)

38180 (NAA-SR-Memo-10720) RE-EVALUATION AND STATISTICAL APPLICATION OF HOT CHANNEL FACTORS FOR THE PIQUA REACTOR. Hausknecht, D. F. (Atomics International, Canoga Park, Calif.). Mar. 26, 1965. Contract AT(11-1)-Gen-8. 23p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

Previous analysis of the hot channel factors for calculating maximum fuel cladding surface temperatures and heat fluxes in the Piqua fuel elements was performed when the reactor was in the design stage. In light of operating experience, a revised analysis was undertaken for the purpose of eliminating undue restriction of reactor operation. The cause, magnitude, and manner of application of the hot channel factors were examined. Previously applied factors as well as additional ones were considered. The variations from nominal represented by all of the applicable factors were then combined, using a standard statistical approach and assuming no correlation between different causes. Based on comparisons with measured cladding surface temperatures, the new results appear to be conservative. (auth)

38181 (ORNL-3807) GAS-COOLED REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING MARCH 31, 1965. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 316p. Dep.(mn); $7.00(cy), 5(mn) CFSTI.

Progress is summarized in sections on fueled graphite development, fueled-graphite systems investigations, German Pebble Bed Reactor development, moderator materials research, advanced reactor systems research, heat transfer and fluid flow investigations, EGCR performance analyses, EGCR component testing, radiation effects on EGCR materials, and EGCR operator training systems. Separate abstracts were prepared for each section. (J.R.D.)

For abstracts of individual sections see: 36612, 36959, 36960, 36961, 36962, 37170, 38082, 38182, 38183, and 38184.

38182 (ORNL-3807, pp 221-37) PERFORMANCE ANALYSES. Perry, A. M. (Oak Ridge National Lab., Tenn.).

A survey was made of experiments and calculations on the Doppler coefficient for UO_2 fuel and the results were compared with a reinterpretation of the measurement of this quantity for the EGCR lattice that was made with the use of the Physical Constants Test Reactor. No reason was found for rejecting the measured value, even though the work of others indicates a value 15% lower. Methods for solving space-time transient problems in nonuniform reactors were developed as an aid in the planning of physics experiments for the EGCR commissioning program. One of the most useful applications of these methods has been the theoretical simulation of transient experiments. The residual flux or power level in the EGCR resulting from multiplication of the external Sb–Be neutron source when the reactor is subcritical was studied, since it is important to keep this background flux as low as possible during transient experiments designed to measure the core reactivity. For the two control rod configurations examined, the calculated core power was well below the tolerable level set for the experiments. (auth)

38183 (ORNL-3807, pp 238-48) COMPONENT DEVELOPMENT AND TESTING. Savage, H. W.; Harms, W. O. (Oak Ridge National Lab., Tenn.).

The two main coolant blowers and the two vessel-cooling compressors were installed in the EGCR. Construction of the compressor seal testing facility was completed, and tests are in progress. Construction of the nondeferred portion of the EGCR experimental loops was essentially completed. Environmental testing of the prototype control-rod drive for the EGCR showed that the unit meets design requirements. A 32-labyrinth-ring geometry was selected for regulating the coolant flow in the graphite surveillance channel. This selection was based on the results of tests with 20, 24, 28, 32, and 36 rings. Additional data were obtained on graphite reaction rates and H_2 generation rates resulting from the exposure of EGCR core graphite to superheated steam. The dimensional stability of nitrided type 304 stainless steel nozzles at 1050°F in flowing He that approximates the purity expected in the EGCR is being tested. After 3200 hr, the nozzles are registering a posi-

tive temperature error of 95°F due to constriction by gradual oxidation. An increase in the temperature error was observed during the last 800-hr period. (auth)

38184 (ORNL-3807, pp 277-85) OPERATOR TRAINING AND CONTROL SYSTEMS ANALYSES. O'Brien, H. G.; Walker, C. S. (Oak Ridge National Lab., Tenn.).

A training simulator was prepared to give EGCR operators practice in operation, and to evaluate the performance of several automatic control systems. The main components in the EGCR plant were simulated on the ORNL analog computer, and the simulated plant was controlled with a portable console. The equipment that was supplied by the vendor for the rod and blower control systems was used in conjunction with the simulator. In preparation of the training simulator, it was found that the plant could not be satisfactorily controlled with the original automatic system. One of the alternate control systems examined was that of a rod controller having reactor power as its input signal with a blower controller having coolant flow as its input signal. This control system gave adequate performance, and it was used in the operator training program. Another system was examined that is capable of operating in a load-following mode wherein the reactor power is dependent on the turbine load. The control system was able to make the plant follow large changes in turbine load at the rate of 10%/min and small changes in turbine load at the rate of 1%/sec while maintaining the transient variations in steam conditions within acceptable limits. (J.R.D.)

38185 (ORNL-P-1278) ECONOMIC ASPECTS OF NUCLEAR DESALINATION. Burwell, C. C. (Oak Ridge National Lab., Tenn.). May 3, 1965. Contract W-7405-eng-26. 18p. (CONF-650532-1). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Institute of Nuclear Materials Management Meeting, Cincinnati.

It may be stated that distilled water may be economically produced by distillation in a large dual-purpose nuclear facility. Projected water costs will be low enough for agricultural purposes if full advantage is taken of the favorable cost features of by-product electricity, natural uranium or breeder fuels, a large fuel-processing industry, and large-size construction. Further reductions in water cost will undoubtedly occur as the results of research and development are applied to the nuclear desalination industry. (auth)

38186 (ORNL-TM-1145) THE TECHNICAL AND ECONOMIC CHARACTERISTICS OF THORIUM REACTORS. Rosenthal, M. W.; Bauman, H. F.; Bennett, L. L.; Carlsmith, R. S.; Vondy, D. R. (Oak Ridge National Lab., Tenn.). June 3, 1965. Contract W-7405-eng-26. 28p. (CONF-650615-4). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From IAEA Panel on Utilization of Thorium in Power Reactors, Vienna.

Six thorium-fueled reactors are described briefly and their engineering performance requirements are discussed. The economic context for the evaluation is outlined, and some general comments are made on the physics of thorium reactors. The fuel utilization of specific reactors is presented, and the fuel cycle, capital, and operating costs of the reactor are reported. (M.O.W.)

38187 (ORNL-TM-1147) THE ECONOMIC INCENTIVE FOR THORIUM REACTOR DEVELOPMENT. Lane, James A. (Oak Ridge National Lab., Tenn.). June 2, 1965. Contract W-7405-eng-26. 20p. (CONF-650615-2) Dep.(mn); $1.00(cy), 1(mn) CFSTI

From IAEA Panel on Utilization of Thorium in Power Reactors, Vienna.

The role of thorium breeders and converters in the overall development of power breeders along the optimum economic path is outlined. Various fuel cycles are considered, as are the fuel utilization characteristics of several power breeder concepts. (T.F.H.)

38188 (ORNL-TM-1189) A TECHNIQUE FOR CALCULATING FREQUENCY RESPONSE AND ITS SENSITIVITY TO PARAMETER CHANGES FOR MULTI-VARIABLE SYSTEMS. Kerlin, T. W.; Lucius, J. L. (Oak Ridge National Lab., Tenn.). June 24, 1965. Contract W-7405-eng-26. 27p. Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

A general method for calculating the frequency response of a dynamic system and the sensitivity of this frequency response to changes in system parameters is described. The development is carried out using the matrix differential equation (or state variable) approach. SFR-1, a computer code prepared to carry out the computations, is described. Two sample problems serve to illustrate the method and the use of the code. (auth)

38189 (ORO-606(Suppl.I)) REVISIONS TO EXPERIMENTAL GAS COOLED REACTOR FINAL HAZARDS SUMMARY REPORT, AUGUST 1, 1963. VOLUME II. PLANT OPERATION. (Oak Ridge Operations Office (AEC), Tenn.). June 1965. 130p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Revisions to the EGCR plant operation final hazards summary report are presented. Only the pages that have been revised are included, and the revised portions are indicated with arrows. (T.F.H.)

38190 (TID-21970) GARIGLIANO NUCLEAR POWER PLANT WORK PROGRESS IN 4TH QUARTER OF 1964. (Societa Elettronucleare Nazionale, Rome (Italy)). Dec. 31, 1964. 7p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Shutdown for approximately one month is reported. During the shutdown a number of leaks that had been noticed during operation in the reactor canal were located and repaired, the containment sphere was again leak tested and the leakage rate measured. New moisture separators were installed in the crossunder and modifications were made in the turbine control system. Results of these and other modifications are reported. (M.O.W.)

38191 (WCAP-5490) EVALUATION OF γ SCANNING AS A TOOL FOR DETERMINING FUEL BURNUP DISTRIBUTIONS IN LARGE POWER REACTOR CORES. Nodvik, R. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). [1964]. Contract AT(30-1)-3017. 5p. (CONF-650602-9) Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

Using a minature ion chamber, the fuel assemblies were gross gamma scanned in the centerhole which was provided for axial flux wire measurements. The integrated average gamma activity of each assembly, normalized to the core average, is compared to the normalized burnup. A table showing this comparison is presented. (M.O.W.)

38192 (WCAP-5494) FUEL BURNUP IN HETEROGENEOUS REACTOR LATTICES. Poncelet, C. G. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). [1964]. Contract AT(30-1)-3017. 4p. (CONF-650602-4). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

A model which accounts for the detailed spatial nonuniformities within a lattice cell and which accounts for all nonlinearities and mutual connections in the system of equations is discussed. Calculations were performed for the Yankee Core and compared to experimental data obtained as part of the Yankee Core Evaluation Program. (M.O.W.)

38193 (WCAP-5495) REACTOR PHYSICS CONSIDERATIONS IN THE DESIGN OF A POWER REACTOR PARTIALLY LOADED WITH PuO_2-UO_2. Risti, H. A.; Impink, A. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). [1964]. Contract AT(30-1)-3385. 7p. (CONF-650602-7). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburgh, Tenn.

In the survey calculations leading to the design of the Saxton Core II, the multi-group, spectrum-dependent, non-spatial LEOPARD depletion code was employed for generating the group parameters. Calculations were made to determine the enrichment of PuO_2 to be added to natural UO_2 for a chemical shim, partially loaded core. Highlights obtained through this design study are presented. (M.O.W.)

38194 (WCAP-6071) EXPERIMENTALLY DETERMINED BURNUP AND SPENT FUEL COMPOSITION OF YANKEE CORE I. Jedruch, J.; Nodvik, R. J. (Westinghouse Electric Corp.). July 1965. Contract AT(30-1)-3017. 131p. Dep. mn; CFSTI, $4.00 cy, $1.00 mn.

The results of mass spectrometric analysis of spent fuel samples from Yankee Core I were used to infer the assembly and total core inventories of U and Pu isotopes. Agreement to ~1% was found between the measured and calculated U inventories and ~3% between Pu inventories. In addition, the total energy release in the core, inferred from the results of mass spectrometric and radiochemical (Cs-137) analyses, was found to be 8.40 ± 0.21 and 8.44 ± 0.24 GWD/MTU, respectively. These values of total core burnup agree to within 1% of the total core burnup inferred from calorimetric data obtained during reactor operation. The fuel assembly average burnup inferred from isotopic, Cs-137, and flux wire data agree within experimental error. (auth)

38195 (ZFK-RN-30) UNTERSUCHUNGEN UBER DIE WIRTSCHAFTLICHE ANWENDUNG DER KERNENERGIE. (Study on an Efficient Application of Nuclear Energy). Schwarz, Karl (Duetsche Akademie der Wissenschaften zu Berlin (East Germany) and Zentralinstitut fur Kernphyaik, Rossendorf bei Dresden (East Germany)). Nov. 1964. 38p. Dep.(mn).

The efficiency of nuclear energy installations that produce electrical energy or industrial heat was compared. As a criterion, the permitted specific installation costs were examined when the conventional attainable energy costs were used unaltered as the basis. An advantage of the heat-producing nuclear energy installations was the fact that the conventional heat costs are more dependent on the distance for the coal mines than the electrical energy transmitted from a power plant close to the mine. Even with consideration of variable outputs of the installation it appears that in the range of average outputs nuclear heating installations can compete with the same type of conventional installation far from the mine. The investigations were undertaken from the view point of tested reactor types. This makes it possible to fulfill the requirements of heat supply without temporary arrangements. The development is difficult. The energy industrial favorable heat-power coupling should be studied. (tr-auth)

38196 (NSJ-tr-37) STEEL PLATE FOR NUCLEAR POWER REACTORS. Yoshida, Tatuo; Miyano, Katao; Yoshizawa, Akira. Translated from Nippon Seiko Giho, No. 16, 1782-96(Mar. 1964). 30p. Dep. mn; JCL, $2.60 fs, $1.10 mf.

A discussion is given on how the high quality heavy steel plate for welded structures, first produced in the Muroran Plant in 1961, has been introduced into practical use at the Tokaimura Nuclear Power Station. Several points which have been studied concerning the manufacturing process and the properties of the said plate are also discussed. (D.L.C.)

38197 THE MONITORING AND REGULATING DEVICES AT THE SAINT-DENIS NUCLEAR EQUIPMENT TESTING STATION. De Livois, G.; Roche, R. Automatisme, 9: 471-9(Nov. 1964).

A laboratory was built at Saint-Denis for the industrial-scale testing of the various types of equipment that will go to form future nuclear power stations. The general plant, the fluid circulation circuits, the control and monitoring room, the types of regulators adopted, and future extensions and developments are described. (Summaries Articles French Tech. Press)

38198 PROSPECTIVE FUELLING SYSTEMS FOR THE HEAVY WATER REACTOR. Lewis, W. Bennett (Atomic Energy of Canada Ltd., Chalk River, Ont.) Can. Nucl. Technol., 4: No. 3, 46-50(1965).

At this date the heavy water reactor alone belongs both to the proven and the advanced converter classes. For sentiment rather than economy it could also be pushed into the breeder class. It issues its challenge to all comers including breeders for now and for all the foreseeable future as an economic generator of electricity or process heat for desalination or other large uses. It is an efficient converter requiring only a very small inventory of fuel. It is so flexible in its fuel cycle that the choice can be made a question of the current market situation. When it is no longer cheapest to fuel with natural uranium, plutonium could be recycled or separated uranium-235 or plutonium could give entry to the thorium-uranium 233 cycle. The flexibility of fuelling leads to possible complexity, but the complication is of a nature that can be readily taken care of by a digital computer that issues a simple prescription for the next move to minimize the cost of power, optimize production of cobalt-60 or other isotope to meet a changing market or minimize lost hours in any necessary shut-down. Even an established reactor could have its fuel cycle progressively changed to operate for example with uranium-233 and thorium instead of natural uranium. A reactor optimized for thorium might be smaller but in a reactor designed for uranium oxide there would always be room for thorium fuel. On any fuel cycle involving use of separated fissile material, it is shown that a long term advantage results from associating it with thorium rather than uranium. On the other hand if fast breeder reactors become sufficiently economical and attractive to establish a high value of plutonium, the heavy water reactors would use natural uranium and sell the plutonium produced. A previous study showed that by the thorium-uranium 233 cycle a total energy yield of 50,000 Mwd/ton of natural uranium is assured and there is sufficient uranium available in the world at a low enough cost to supply the world through many centuries using only the neutron economical heavy water reactors. (auth)

38199 THE PROTOTYPE LOADING-UNLOADING MACHINE FOR THE P.R.O. REACTOR. Di Chirico, G.; Merli, E. Comit. Nazl. Energia Nucl., Notiziario, 11: No. 5, 21-8(May 1965). (In Italian)

The design of the fuel element and control rod loading and unloading machine for the organic cooled and moderated P.R.O. Reactor is discussed. Certain test cycles on the prototype machine were performed: the experimental equipment used in these tests, and the results achieved, are discussed. (auth)

38200 NUCLEAR ENERGY FOR POWER GENERATION. Fry, D. W. Electron. Power, 11: 124-9(Apr. 1965).

The development of nuclear power is outlined, and the technology of power reactors is surveyed. (D.C.W.)

38201 THE INDUSTRIALIZATION OF NUCLEAR ENERGY IN EUROPE. Chatenet, Pierre. Energie Nucl., 7: 141-8(May 1965). (In French)

A survey is given of the role of nuclear energy in modern life especially its use in industry. The economic advantages are stressed and the great need for such a source of energy in Europe which does not have the fuel resources of such countries as the United States. The role of the European community in the development of nuclear energy is also discussed. (J.F.P.)

38202 THE EDF. 4 POWER PLANT. BUILDING METHODS. Marchal, Jean-Pierre. Energie Nucl., 7: 149-59(May 1965). (In French)

The general design and development of the Saint Laurent-Des-Eaux Reactor is described. The pressure vessel is of concrete with an outside hexagonal section and internal circular section and has the heat exchanger inside. The arrangement of the reactor support and the exchanger are described. The program of construction is given, and also the administration. The installation area is also described. (J.F.P.)

38203 THE EL 4 REACTOR TANK. Chave, P.; Peuchmaur, A. Energie Nucl., 7: 160-73(May 1965). (In French)

The EL 4 reactor tank, a prototype of a system of power reactors moderated with heavy water and cooled by carbon dioxide under pressure, is both the heavy water container and the support for the pipes containing the fuel. Numerous

pipes meet in the tank and it should assume many functions. Because the tank is dependent on this fact, it was necessary to carry out numerous experiments and tests concerning especially the explosion of a force tube, the hydraulic flow, the resistance of materials. These are briefly described. The problems encountered in the design and the construction of the tank, are presented and the tests which were carried out on models relative to the assembling by welding and later treatments are reported. The various construction phases are described. (auth)

38204 ATOMIC POWER PRODUCTION. Yoshioka, Takao (Japan Atomic Power Lab., Tokyo). Genshiryoku Kogyo, 11: No. 4, 9-14(Apr. 1965). (In Japanese)

The Japanese program for power development from atomic sources was initiated in 1954. The history of subsequent developments in atomic power production is outlined. The Tokai Power Plant (Calder Hall type) is described in detail including items such as selection of maker, general description of plant, construction log, and fuel. Preparation for other power reactors and future plans are described. The present status of power reactors abroad is discussed briefly. The paper is concluded with a short treatment of the economics of atomic power production. (TTT)

38205 NUCLEAR POWER IN THE WORLD TODAY. Roddis, Louis H. Jr. (Pennsylvania Electric Co.). IEEE (Inst. Elec. Electron. Engrs.), Spectrum, 2: 90; 95(July 1965).

A survey is given of nuclear power throughout the world. It is seen that the economic features of nuclear power are a very important part of its development. The European development of nuclear power is given country by country. The Canadian, American, and Russian nuclear power developments are also considered. The future advantages of nuclear power are also pointed out. (J.F.P.)

38206 HEAT TRANSFER AND PRESSURE LOSSES IN A STEAM GENERATOR OF NUCLEAR POWER PLANTS. Vampola, Josef. Jaderna Energie, 11: 163-6(May 1965). (In Czech).

A tube heat exchanger in which gas streams in the annulus and water is heated or evaporated, or steam is superheated, inside the tubes was investigated. Heat transfer coefficients and pressure losses were measured on the gas side. (M.C.G.)

38207 THE EVALUATION AND MEASUREMENT OF REACTOR-SAFETY PERFORMANCE. Larson, H. J.; Stratton, K. (General Electric Co., Pleasanton, Calif.). Nucl. Appl., 1: 225-9(June 1965).

At the Vallecitos Atomic Laboratory a tightly integrated audit system was established among the reactor-operating staff, independent-audit and technical-assistance groups, and laboratory management. Safe operation of the reactors is a responsibility of reactor management, with enforcement of safe practices by laboratory management depending heavily on the review and recommendations of an independent nuclear-safety engineering organization. Cost of the total audit effort is about $60,000/yr, with a similar amount required for nuclear engineering activity supporting the audit. The audit program contributed significantly to increased reactor operation efficiency and cost savings. Several examples that demonstrate tangible benefits derived from this technique are given. (auth)

38208 TIME OPTIMAL SOLUTION TO THE REACTIVITY-XENON SHUTDOWN PROBLEM. Roberts, John J.; Smith, Harold P. Jr. (Univ. of California, Berkeley). Nucl. Sci. Eng., 22: 470-8(1965).

A time optimal criterion for the reactivity-xenon shutdown problem was formulated and solved by application of the theorems of optimal processes as developed by Pontryagin. The minimum time trajectory between any point of operation in the xenon-iodine phase space to a zero-power shutdown curve subject to the constraint that neither the shutdown curve nor the trajectory to the shutdown curve allow the xenon concentration to exceed an arbitrarily specified maximum is sought. The optimal solution is shown to usually require sequential operation at zero power, variable (decreasing) power, and finally full power. The exact power program is calculated for one example. (auth)

38209 PUMICE CONCRETE USED AS THERMAL INSULATION IN PRE-STRESSED CONCRETE PRESSURE VESSELS IN THE E.D.F. REACTORS. Menestrier, Michel (Electricite de France, Clamart, France). Nucl. Struct. Eng., 2: 102-19(July 1965).

In erecting the prestressed concrete pressure vessels used for natural-uranium, graphite-moderated, gas-cooled reactors, the difficulty of thermal insulation of vessel must be forced. For its power plants, EDF 3 at Chinon and EDF 4 at Saint Laurent-des-Eaux, Electricite de France used an insulating material, specially studied and developed for this purpose: pumice concrete. Properties needed for insulating reactor pressure vessels are discussed and detailed information on the nature and the source of the pumice concrete components, the process and manufacture checks, its use in the reactor, and indications concerning principal mechanical and thermal properties are given. Instructions are given on how to put the pumice concrete to various uses. (auth)

38210 ASEISMIC DESIGN AND DYNAMIC ANALYSIS OF NUCLEAR POWER PLANTS. PART II. ROCKING MOTION. Akino, K. (Japan Atomic Power Co.); Tajimi, H. Nucl. Struct. Eng., 2: 120-5(July 1965).

The dynamic analysis applied to the reactor containment building of the JPDR, which was completed in 1963, is described. The analysis included is restricted to the calculation of the vibrational properties of the building, performed on the basis of an assumption that it undergoes a rocking vibration. In addition, measurement of vibrations of the building during small earthquakes is reported and some data are presented as a result of the spectral analysis. Tentative conclusions with regards to the natural period were made by comparison between calculated and measured results. (auth)

38211 PROSPECTS OF NUCLEAR POWER DEVELOPMENT IN YUGOSLAVIA. Suica, Salom. Nukl. Energija, 1: No. 2, 1-7(Feb. 1965). (In Slovenian)

A survey is given of nuclear power development in Yugoslavia. This includes power consumption extrapolations to 1970–1990, possibilities for the coverage of a long-term power balance as regards thermal power resources and hydro power resources. The pattern of power generation and the integration of nuclear power plants are discussed. It is noted that this integration will not coincide with the extinction of conventional sources, since economic and technical improvements will necessitate the integration of nuclear power much earlier. These nuclear power stations will use natural uranium as a fuel and will rely on national raw material resources. (J.F.P.)

38212 NUCLEAR PLANTS FOR WATER DESALTING GETS THOROUGH DISCUSSION AT ATOMIC INDUSTRIAL FORUM. Power Eng., 69: 61-2(Mar. 1965).

A survey is provided of reports on progress in the nuclear desalination program given at the Atomic Industrial Forum at San Francisco on Nov. 30, 1964. Major attention was paid to a large-scale nuclear desalting program that would provide regional water supply plants in the 1970's. Such plants would produce about 500 to 700 mgd (Mgal/day) of water and have an electrical output of over 100 Mw. Best economic potential for these plants seems to reside in the heavy water moderated organic cooled reactor (HWOCR) and the multi-stage flash distillation process (MSF). The first phase of this large-plant program has two objectives: to operate at least one intermediate-size prototype dual-purpose plant of about 50 mgd capacity; and to operate a prototype power-only HWOCR of about 1000 Mw capacity. These two objectives are scheduled to be achieved by 1970. In the second phase, a large dual-purpose prototype plant would employ a nuclear-energy source. General recommendations call for expanded research and development efforts in all phases of the program, and an increase of $200 million in authorized expenditures through 1972. At

present, the HOWCR concept is considered most promising for combination plants. Units up to 100,000 Mw are considered technically feasible at this time, and the reactor has the potential for low-energy costs in power-only or dual-purpose plants. It is recommended that large dual-purpose plants be developed as soon as possible, in an effort to achieve water costs in the range of 20 cents/1000 gal. Dual-purpose plants are envisioned that produce up to a billion gallons of water a day and thousands of megawatts of power. (TCO)

38213 NUCLEAR POWER ECONOMICS. Taylor, E. O. Technologist, 1: No. 4, 30-7(1964).

An economic appraisal of existing and projected stations in U. K. and U. S. A., with comparison between types and estimates of future performance, is presented. (auth)

38214 THE ECONOMICS OF NUCLEAR POWER. Hasson, J. A. London, Longman, Green and Co., Limited, 1965. 166p. 35 shillings.

Information is included on: methodology for evaluating nuclear power costs; economic welfare, structural change, and nuclear power; benefit-cost analysis of nuclear power developments; and factors in the choice among alternatives. Methodological analysis of nuclear fuel burn-up, application of the methodology, and tables of nuclear power costs are appended. (P.C.H.)

38215 COMPACT, DEMAND CONTROLLED, WATER COOLED NUCLEAR REACTORS FOR UNDERWATER SERVICE. Zmola, P. C. (Combustion Engineering, Inc., Windsor, Conn.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint AIAA Paper No. 65-572, 12p. $1.00. (CONF-650610-7). ORINS

From American Inst. of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs.

The principal characteristics of a compact, water-cooled nuclear steam generator appropriate for use in underwater applications where power in the range of 1000 to 7000 SHP would be required are outlined. The reactor employs natural circulation of the primary coolant; and the entire primary system is enclosed within a single pressure vessel. In operation, the system is controlled completely by steam demand without the use of control rods. Results of analog calculations are presented which indicate favorable steam demand response characteristics as well as stability to imposed motion. Two versions of the nuclear steam generator are described; one 8 Mwth (1500 SHP) and the other 16 Mwth (3500 SHP). Shielded specific weights are 125 and 100 lbs/SHP respectively. Size, weight, and performance parameters, and unit costs exclusive of initial development are presented. (auth)

38216 CANDU TYPE REACTORS FOR DUAL PURPOSE POWER AND DESALINATION PLANTS. Wyatt, A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Toronto, Canadian Nuclear Association, 1965, Preprint No. 65-CNA-211, 28p. (CONF-650515-7). ORINS

From International Conference and Exhibition of Canadian Nuclear Assn., Quebec.

The economics of operating a CANDU type reactor is considered relative to the particular circumstances of the U.S./Israel study. Since the economics are favorable, a discussion of system planning aspects of dual power and desalination plants is also presented with brief summaries of the main desalination processes and of costs. Charts and diagrams are included. (J.F.P.)

38217 STATUS AND PERFORMANCE OF NPD AND DOUGLAS POINT. Beaver, J. W. (Hydro Electric Power Commission of Ontario, Rolphton). Toronto, Canadian Nuclear Association, 1965, Preprint No. 65-CNA-216, 17p. (CONF-650515-4). ORINS

From International Conference and Exhibition of Canadian Nuclear Assn., Quebec.

The Nuclear Power Demonstration Reactor has on power fueling and uses heavy water as a moderator and for heat transport. The performance is described and objectives of training staff, developing alternative concepts, and tests and measurements are discussed. The Douglas Point Reactor is also discussed regarding its present status of development. (J.F.P.)

38218 THE FRENCH NUCLEAR POWER STATION EL-4. Brisset, J. C. (Electricite de France, Paris). Toronto, Canadian Nuclear Association, 1965, Preprint No. 65-CNA-212, 23p. (CONF-650515-6). ORINS

From International Conference and Exhibition of Canadian Nuclear Assn., Quebec.

A description of the EL 4 Reactor is given. The fuel consists of natural uranium sheathed in very low absorptive materials. The reactor is overcontrolled. It uses gas bars and soluble poison which produce homogeneous compensation without distorting the flux. (J.F.P.)

38219 OTHER APPLICATIONS OF NUCLEAR ENERGY. Cochran, D. R. (Canadian General Electric Co. Ltd., Toronto). Toronto, Canadian Nuclear Association, 1965, Preprint No. 65-CNA-201, 40p. (CONF-650515-14). ORINS

From International Conference and Exhibition of Canadian Nuclear Assn., Quebec.

A survey of applications of nuclear energy is given. This includes its use in utilities, propulsion, industry, and desalination. (J.F.P.)

38220 PRESSURIZED WATER NUCLEAR REACTOR. (to Societe Rateau). German Patent 1,189,665. Mar. 25, 1965. Priority date June 20, 1958, France.

The reactor system described consists of an active portion in a pressure vessel, a nozzle exterior to the pressure vessel, an expansion chamber associated with the nozzle in which the liquid is vaporized, and conduit means connected to the expansion chamber, whereby the vaporized fluid flows through an energy-consuming unit for the generation of power. In front of the nozzle inside the expansion chamber there is a hydraulic action turbine activated by the jet of water and steam ejected from the nozzle. This action turbine drives the circulation pump in the cooling circuit. (Gmelin Inst.)

38221 METHOD OF OBTAINING A UNIFORM POWER DENSITY IN GAS-COOLED, BALL-FUELED, HIGH-TEMPERATURE NUCLEAR REACTOR. Schulten, Rudolf (to Brown, Boveri and Cie. and Beteiligungs- und Patentverwaltungsgesellschaft mbH). German Patent 1,191,049. Apr. 15, 1965. Filed Mar. 4, 1961.

The method consists of counting the elements (fuel elements, dummy elements, or elements of fertile material) removed through the discharge channel at the center of the bottom of the core, of evaluating the size of the cone of charge from the number of discharged elements, and of introducing elements according to the evaluated size. (Gmelin Inst.)

38222 BOILING-WATER NUCLEAR REACTOR WITH STEAM SUPERHEATING. Straat, Matts Valter (to Aktiebolaget Atomenergi). German Patent 1,194,512. June 10, 1965. Priority date Dec. 4, 1962, Sweden.

A boiling-water reactor is provided with separate elements for the generation of steam, for drying the steam, and for superheating the steam. The elements for drying the steam are disposed above the core but still within the influence of the neutron flux. (Gmelin Inst.)

38223 STEAM-COOLED NUCLEAR REACTOR POWER PLANT. Nettel, Frederick; Nakanishi, Tetsuichiro. U. S. Patent 3,175,953. Mar. 30, 1965. Filed Feb. 27, 1962.

A steam power plant is described that uses a modified Loeffler boiler system in combination with a nuclear reactor. Saturated steam from an evaporator drum partly filled with water is superheated by leading it through passages containing fuel provided in the reactor. A first-part stream of this superheated steam is led into a turbine where it produces useful power. This first-part stream is led in counterflow heat exchange relationship to a second-part stream of the superheated steam issuing from the reactor for reheating the first-part stream. This reheated steam is then led back to the turbine for further expansion and subsequently into a condenser to produce more useful

power. After the second-part stream has lost part of its superheat by reheating the first-part stream, it is led back to the evaporator drum where it loses the remaining superheat to generate saturated steam from the condensate of the first-part stream. The saturated steam is pumped back through the reactor where it is again superheated. The steam flows in two substantially closed parallel-flow circuits: one to serve the steam turbine, the other the reheater and evaporator drum. (B.L.M.)

38224 SUPERHEATER REACTOR. Kornbichler, Heinz; Fishcher, Erhard; Kluge, Hans (to Licentia Patent-Verwaltung-GmbH). U. S. Patent 3,188,277. June 8, 1965. Priority date Feb. 26, 1959, Germany.

The superheater reactor patented is intended for use with at least one other reactor in a nuclear power plant. The core of the reactor is formed of tubular elements containing the fuel elements and simultaneously serving as cooling channels. The tubular elements are arranged to form an inner zone and an outer zone. Moderating water fills the space between the tubular elements, and the fuel elements are thermally insulated from the moderating water. Saturated steam produced in another reactor passes first through the outer zone to be presuperheated, and then passes in the opposite direction through the inner zone to attain its maximum temperature. (A.G.W.)

38225 NUCLEAR REACTOR POWERED STEAM GENERATING SYSTEMS. Dodd, John Alan (to United Kingdom Atomic Energy Authority). U. S. Patent 3,190,808. June 22, 1965. Priority date June 1, 1960, Great Britain.

A system is described for removing shutdown heat from the core of a nuclear-reactor-powered steam generating system when pumping power is not available to circulate the coolant. The steam generator is placed higher than the reactor core so that convection flow of reactor coolant can be maintained. The steam generator is supplied with water and arranged to feed steam to a steam drum disposed so that convection flow of water through the steam generator can be maintained. A circuit is provided for removal of steam from the drum so that the steam can be moved by convection flow through a heat sink and return as water to the drum. If an organic liquid coolant is used, arrangements are provided to prevent solidification of the coolant. (A.G.W.)

38226 NUCLEAR REACTOR SYSTEMS. Challender, Ronald Scott; Laithwaite, John Michael; Lawton, William Thexton; Griffiths, Jack Jones (to United Kingdom Atomic Energy Authority). U. S. Patent 3,192,121. Priority date Nov. 2, 1960, Great Britain.

The reactor system patented includes a reactor core contained within a spheroidal pressure vessel and coaxial inlet and outlet coolant ducts connecting with a heat exchanger in a generally horizontal plane. The pressure vessel is supported in its upper regions by hangers depending from a support structure, which is carried on struts matched with the hangers so as to maintain the plane of the coaxial ducts in a constant position. The core is carried on a grid structure supported by hangers from the plane of the coaxial inlet and outlet ducts. The heat exchanger is supported from hangers depending from support beams set in the concrete biological shielding. (A.G.W.)

Process Heat Reactors

38227 DESALINATION: THE "POOR MAN'S" SPACE PROGRAM. Law, C. Arthur. Can. Nucl. Technol., 4: No. 3, 51-4(1965).

A survey of the current status of nuclear desalination technology indicates the main areas of world demand, the state of the art in the engineering and technology of large saline-water conversion plants, as well as results of recent research in the design of multi-stage flash and tube-type evaporators. A review is made of the effects of the application of process heat from nuclear reactors to the economics of large scale desalination, with special attention to the role of heavy water moderated "high convertor" reactors. (auth)

Production Reactors

38228 (BNL-9271) TRANSURANIUM ELEMENT PRODUCTION IN EPITHERMAL REACTORS. Epel, L. G.; Chernick, J.; Manowitz, B.; Winsche, W. E. (Brookhaven National Lab., Upton, N. Y.). June 1965. Contract AT (30-2)-Gen-16. 25p. (CONF-650602-30) Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

An investigation was made of the effects of hardening the neutron spectrum on the yield of the two transuranium nuclides ^{238}Pu and ^{244}Cm. Three spectra were utilized for each of the two nuclide chains and yields of the desired products were calculated. It was found that a hardened spectrum which took advantage of the resonance capture integrals of some of the isotopes in the chain enhanced the yield significantly. Epithermal reactors will also produce transplutonium elements more economically. (D.L.C.)

38229 (WCAP-5492) RESULTS OF COMPARISONS OF THERMAL CALCULATIONAL MODELS FOR HETEROGENEOUS LIGHT-WATER-MODERATED PuO_2-UO_2 REACTOR SYSTEMS. Risti, H.; Krug, H. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). [1964]. Contract AT(30-1)-3285. 6p. (CONF-650602-5) Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

Comparisons of thermal calculational models for heterogeneous light-water-moderated PuO_2-UO_2 reactor systems were performed. The Wigner-Wilkins differential equation with volume weighted number densities influenced by energy-pointwise Amouyal-Benoist flux disadvantage factors in a SOFOCATE cross section library scheme was compared with the more refined heterogeneous thermal calculational model used in the THERMOS code. Results are presented. (M.O.W.)

38230 CONTINUOUS ON-REACTOR MEASUREMENT OF INSTANTANEOUS CORROSION RATES. Richman, R. B. (Battelle Memorial Inst., Richland, Wash.). Nucl. Appl., 1: 267-70(June 1965). (HW-SA-3599)

Methods were devised to use electrical resistance probes in the low-temperature water-cooled Hanford reactors to measure corrosion continuously during reactor operation and during chemical decontamination. The changing resistance of a corroding test element was compared with the resistance of a protected reference element. Typical probe results showed carbon steel corrosion ranging from a 1 unit/yr equilibrium rate to a 1050 units/yr maximum rate during decontamination. (An arbitrary rate scale is used to obviate security classification.) Total corrosion from decontamination was equal to about 1.5 months of reactor operation. (auth)

Propulsion and Space

See also ENGINEERING — Space Propulsion.

38231 (GEMP-359) 630A MARK V MARITIME NUCLEAR STEAM GENERATOR DESIGN STUDIES SUMMARY 630A PROGRAM OPERATION. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Mar. 31, 1965. Contract AT(40-1)-2847. 101p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Optimization and design studies are reported on major components (e.g., fuel rods and gas circulators) of the Mark V Maritime Nuclear Steam Generator 630A. Nuclear evaluations, thermodynamic optimizations and off-design-point studies, and safety calculations are also included. (T.F.H.)

38232 (HW-SA-3330) DETERMINATION OF FAST-NEUTRON SPECTRA IN N-REACTOR CORE BY EXPERIMENTAL AND ANALYTICAL METHODS. Dahl, R. E.; Ulseth, J. A. (General Electric Co., Richland, Wash. Hanford Atomic Products Operations). July 8, 1964. Contract AT(45-1)-1350. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Fast-neutron spectra in the NPR core are analyzed, in order to support radiation damage studies and provide a basis for anticipating physical and mechanical properties induced in the moderator by neutron bombardment. Calculations are made with a transport-theory analysis to determine spectral shifts and intensity gradients within a lattice. The spectra determined by this means are used to correlate irradiation test data to predict in-service graphite behavior. Spectral determinations are also made with ^6Li spectrometers within the reactor core during low-power operation. Agreement is obtained in initial tests between calculated and experimentally determined spectra; however, discrepancies appeared in further tests. (auth)

38233 (IDO-17065) POST-TEST PHYSICAL, CHEMICAL AND METALLURGICAL ANALYSIS OF SNAPTRAN-3 FUEL. Fletcher, R. D. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). June 1965. Contract AT(10-1)-205. 72p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

The fuel element damage which occurred during the SNAPTRAN-3. Destructive Test of a Snap 10A/2 reactor is described. Chemical analysis of the fuel indicated that approximately 15% of the hydrogen was released and that the core flux was higher toward the center both radially and axially. Metallurgical analysis of the fuel determined the presence of the epsilon, delta, and gamma phases in the grain structure and evidence of a possible alpha or beta phase. The phase changes indicated a minimum peak fuel temperature of 1290°F while cracking at the grain boundries indicated a peak fuel temperature in excess of 1740°F. The failed edges of the fuel cladding suggested a peak clad temperature in excess of 1000°F. (auth)

38234 (LA-3286) INTEGRAL GAMMA AND NEUTRON MEASUREMENTS ON THE KIWI B4D-202 AND KIWI B4E-301 REACTORS. Worman, F. C. V.; Lee, P. K. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Mar. 30, 1965. Contract W-7405-eng-36. 101p. Dep. mn; CFSTI, $4.00 cy, $0.75 mn.

An evaluation of the leakage radiations produced by the Kiwi B4D-202 and Kiwi B4E-301 reactors is given. Integral measurements of gamma dose, neutron flux, and neutron dose were made on all experimental plans that involved criticality. For reactor Kiwi B4D-202, these were Experimental Plan 2, a calibration run; Experimental Plan 3, a power profile or low power run; and Experimental Plan 4, a full power run. Kiwi B4E-301 involved a calibration run, Experimental Plan 3; a low power run, Experimental Plan 4; a full power run, Experimental Plan 5; and a restart and second full power run designated Experimental Plan 6. Gamma doses in air on Experimental Plan 4, Kiwi B4D, ranged from 1.12×10^5 rads at 60 feet to less than 20 rads at 1,800 feet. Neutron doses in air varied from 6.43×10^4 rads at 60 feet to 2.64 rads at 3,000 feet. Thermal neutron fluxes declined from 87.2 per cent of the total fast neutron flux at 60 feet to 24.6 per cent at 1,500 feet. Comparable data for Experimental Plan 5 of Kiwi B4E show the gamma doses in air ranging from 5.93×10^5 rads at 60 feet to 1.93×10^2 rads at 1,800 feet. Neutron doses in air varied from 2.21×10^5 rads at 60 feet to 3.24 rads at 3,000 feet. Thermal neutron fluxes diminished from 123 per cent of the total fast neutron flux at 60 feet to 28.8 per cent at 1,500 feet. Documentation of the radiation field in close proximity to the reactor core was accomplished on Kiwi B4D by using two meridian rings, an inner ring at a 50 inch radius from the core center of the reactor and an outer ring at 90 inches from the same point. On Kiwi B4E only the outer ring was utilized. The meridian rings were used only on the calibration runs. Radiation measurements were also made at shielded positions in and around the test cell on experimental plans for both reactors. (auth)

38235 (LA-3296) INTEGRAL GAMMA AND NEUTRON MEASUREMENTS ON THE NRX-A2 REACTOR. Worman, F. C. V.; Lee, P. K. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Apr. 12, 1965. Contract W-7405-eng-36. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Data are presented on integral neutron fluxes and gamma and neutron rad doses measured on Experimental Plans 2, 4, and 5 of the NRX-A2 reactor tests. Studies included a 2,700-foot freeline, a meridian ring, and an equatorial ring. Neutron fluxes and gamma and neutron rad doses exhibited a close approximation to an inverse square relation, with air attenuation, along the freeline. Since the NRX-A2 reactor was similar to the Kiwi B reactors, data were compared with earlier Kiwi B data. Information obtained from these studies indicated that the radiation leakage patterns observed for NRX-A2 were very similar to those of the reactors of the Kiwi B series. (auth)

38236 (LA-3313) APPLICATION OF MINIATURE INTRINSIC THERMOCOUPLES FOR REACTOR-TRANSIENT DIAGNOSTICS. Morrison, Roderick G. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). May 1, 1965. Contract W-7405-eng-36. 28p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

In a reactor environment, the effects of radiation on the sensing element used in electrical measurements sometimes obscures the desired data. The nature of thermoelectric sensors is such that these effects can be held to a minimum. The use of the actual fuel material as a part of the sensing element removes most energy transfer functions and enables energy deposition to be measured directly as a temperature increase. To overcome thermal time lags and come closer to actual temperatures, fine thermocouple wires 0.001 in. in diameter were welded to small fuel particles 0.016 in. in diameter. The techniques used and the data results from an experiment conducted on Kiwi-TNT are discussed. (auth)

38237 (LA-3336) HIGH-TEMPERATURE REACTOR CORE THERMOCOUPLE EXPERIMENTS. Prince, W. R.; Sibbitt, W. L. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Apr. 30, 1965. Contract W-7405-eng-36. 21p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

The combination of environment and required thermocouple location imposes definite limitations as to the temperature level and accuracy of thermocouple measurements in the Kiwi reactor cores. The thermocouples are required to operate in a hostile environment deep in the reactor core: in hot hydrogen, in direct contact with graphite, and under intense nuclear radiation. Experimental measurements of temperatures up to 4800°F using both prototype and actual reactor hardware thermocouples were made under simulated reactor environment (no irradiation) in an electric resistance furnace. Results indicate that the upper limit for the conventional operation of thermocouples in graphite reactor cores is restricted by the metal-carbon eutectic melting of the sheath. Errors in the indicated signal, depending upon the type and geometry of the thermocouple and length exposed to high temperature, can be as much as 1500°F at a true temperature of 4500°F due to excessive leakage currents between the wires. An acceptable thermocouple, as determined by maximum allowable operating temperature and lowest signal error, was a $\frac{1}{8}$-inch-diameter tantalum sheathed thermocouple having swaged beryllium oxide insulators and 20-mil W-W26Re wires. Calculations indicate that additional errors in local temperature measurements are also possible as a result of the nuclear heating of the thermocouple assembly. (auth)

38238 (LA-DC-6447) OCEAN DROP-H_2O DENSITY BEHAVIOR IN NUCLEAR ROCKET REACTORS BY FAST GAMMA-RAY TECHNIQUES. Rogers, John D.; Bateman, Alfred,; Schneider, Lawrence (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [n.d.]. Contract W-7405-eng-36. 25p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

A study was conducted of transient water density in nuclear rocket reactor flow channels. The tests, using fast measuring techniques of gamma rays, simulated the time-density characteristics for dropping a rocket reactor into

an ocean at various velocities. Observations were made at approximately one and two feet along the flow channel. Four impact velocities of 60, 90, 150, and 225 feet per second were used. Time-density curves indicating a transition from a low density precursor to full density water were obtained. Flow channel frictional effects as compared with entrance effects were found to be important at low impact velocities but not at high impact velocities. (auth)

38239 (LA-DC-6958) THE LOS ALAMOS COUPLED REACTOR EXPERIMENT: KINETIC ANALYSIS. Chezem, C. G.; Helmick, H. H. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [n.d.]. Contract W-7405-eng-36. 5p. (CONF-650602-12). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

Two uranium-graphite fueled, beryllium reflected, Kiwi reactors were operated together in order to ascertain coupling effects on kinetics. The time behavior of the neutron populations in each core of a lumped-parameter m-core array where core No 1 is pulsed is examined. A kinetic model is reported and results of verifying calculations are included. (M.O.W.)

38240 (LA-DC-6968) LOS ALAMOS COUPLED REACTOR EXPERIMENTS: TECHNIQUES. Helmick, Herbert H.; Chezem, Curtis G.; Seale, Robert L. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [n.d.]. Contract W-7405-eng-36. 4p. (CONF-650602-14). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

Two uranium-graphite fueled, beryllium reflected, Kiwi reactors were operated together in order to ascertain coupling effects on reactivity, kinetics, and power distribution. Results are presented. (M.O.W.)

38241 (LA-DC-6979) THE IMPORTANCE OF QUALITY CONTROL AND INTEGRITY CHECKING. Bronson, J. C. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 7p. (CONF-650605-1). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Conference on Design of Leak Tight Fluid Connectors, Huntsville, Ala.

With the assumption that future reactors will run at higher power levels and pressures, a survey of all cryogenic service piping adjacent to the reactor, for integrity, was instigated. Testing was not limited solely to cryogenic hardware but instrumentation pass-throughs, gas service piping, hydraulic seals, actuators, etc. were also checked. In addition to components that were used or are now in use, cold seals and new hardware are evaluated before they are incorporated into new reactor designs. (M.O.W.)

38242 (LA-DC-7003) THE BEHAVIOR OF COATED PARTICLE FUELS IN A LARGE NUCLEAR TRANSIENT (KIWI TNT). Geer, W. U.; Hoffman, C. G.; Kerrisk, J. F. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 4p. (CONF-650602-13). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

An experimental description is given, and the coated particles used are listed in a table. Recovered samples were examined. The fissions per gram of ^{235}U of each sample were determined by gamma counting of each sample and radiochemical analysis of two representative samples. (M.O.W.)

38243 (LA-DC-7005) ANALYSIS OF THE KIWI-TNT EXPERIMENT. Stratton, W. R.; King, L. D. P. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1963]. Contract W-7405-eng-36. 4p. (CONF-650602-18). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

The theoretical method used to describe the nuclear excursion is examined. The calculational scheme is of the type known as a coupled hydromechanical-neutronic code. In this method the reactor is divided into an arbitrary number of contiguous regions, each of which is fully specified at t = 0 by its volume, mass, composition, internal energy, neutron flux, and equation of state. (M.O.W.)

38244 (N64-24160) BUBBLE MOTION STUDIES FOR THE LIQUID CORE NUCLEAR ROCKET. Aeronautical Engineering Laboratory Report No. 672. Lieberherr, J. E.; Williams, Peter M. (Princeton Univ., N. J. Guggenheim Labs. for the Aerospace Propulsion Sciences). Dec. 31, 1963. 64p. (NASA-CR-56229). CFSTI.

Pertinent areas of study in relation to the liquid-core nuclear rocket are the flow and heat-transfer characteristics of multibubble streams in which the bubbles are not necessarily spherical. Techniques for the measurement of three-dimensional velocities of single- and multiple-bubble streams of nitrogen in room-temperature water were developed. The relation between vertical and horizontal velocities in the critical region was investigated. No information of direct application to the liquid-core nuclear rocket has evolved, but the fundamental uncertainties in the bubble regimes of interest to the liquid-core nuclear rocket are defined. (auth)

38245 (N64-29727) STUDY ON APPLICATION OF NUCLEAR ELECTRICAL POWER TO MANNED ORBITING SPACE STATIONS. PHASE III. SNAP-8 EVALUATION AND DEVELOPMENT PROGRAM RECOMMENDATIONS. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Sept. 7, 1964. Contract NAS 3-4160. 133p. (NASA-CR-54160; 64SD914)

Factors studied include the design considerations for replacement powerplants, methods of assuring system restart capability, instrumentation and controls for man-rating, and SNAP-8 growth potential. In addition, a comparison of solar photovoltaic and SNAP-8 power systems, at a power level of 40 kw, for a large 3-spoke station is presented, and recommendations are made for providing information essential to man-rating from the present SNAP-8 development program. (auth)

38246 (NAA-SR-10717) IRRADIATION OF SNAP-10A CONTROL DRUM DRIVE ACTUATORS AND POSITION SENSORS. Warren, M. (Atomics International, Canoga Park, Calif.). May 15, 1965. Contract AT-11-1-GEN-8. 62p. Dep.; $3.00(cy), 2(mn) CFSTI.

Two flight-type control-drum drive actuators and two flight-type control-drum position sensors were subjected to nuclear radiation as part of a program to evaluate the effects of reactor radiation on the electric properties and operation of the high-temperature electric components of the SNAP-10A reactor control system. This experiment also served as part of a program to qualify these components for flight reactor use. These components were tested in the combined environment of reactor radiation, high temperature, and vacuum in order to simulate the SNAP-10A reactor operational environment during space flight. All of the test components performed properly during this experiment. The radiation environment had no apparent effect on the functionality or performance of the test devices. The functionality of each component was tested in-pile as the experiment proceeded. All performance data such as coil resistances, electric insulation resistances, and temperatures were also measured in-pile throughout the experiment. The test components were subjected to postirradiation examinations in a hot cell. Static and dynamic torque measurements were performed. The actuators were completely disassembled, and the internal parts were carefully examined for signs of damage. The examinations showed that there were no significant changes that occurred that could be attributed to the radiation environment. The slight variations in appearance from that of a new component were attributed to the high temperature operating environment. (auth)

38247 (NAA-SR-Memo-10676) EMITTANCE AND SOLAR ABSORPTANCE TEST-SNAP 10A, FS-4. Crosby, J. R. (Atomics International, Canoga Park, Calif.). Jan. 27, 1965. Contract AT-11-1-GEN-8. 4p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

The thermal emittance and solar absorptance properties of the S10A, FS-4 system components were measured at two time intervals 1) prior to NaK loading of the system and 2) subsequent to the thermal acceptance test. The results of these measurements are included. Results attained from measurement of the FS-3 system prior to NaK loading are included for comparison. The metallic control surfaces, i.e., beryllium, stainless steel, and titanium, show approximately a 50% emittance increase following thermal test. The emittance properties of the Al93 and the Cr_2O_3 coating system remained relatively stable. The solar absorptance of the Al93 on the T/E converter fins increased 25%. (auth)

38248 EXPERIMENTAL NUCLEAR ORE-CARRIER OTTO HAHN. Engineer, 219: 54-6(Jan. 1, 1965).

The 15,000-ton (deadweight) ore-carrier, which is to be commissioned in 1967, is briefly described, with emphasis on the reactor designs considered and on the pressurized reactor selected. (D.C.W.)

38249 ATOMIC POWERED SHIP. Takata, Ken (Ministry of Transportation, Japan). Genshiryoku Kogyo, 11: No. 4, 51-5(Apr. 1965). (In Japanese)

The program for development of an atomic powered ship for commercial use is reviewed. A timetable was drawn up for the various phases, and it is hoped that first trials of the ship will be sometime between 1968 and 1970. Financing for this venture is with funds derived from both government and civilian sources. A table is presented, which lists the various projects under way, the responsible organization, and the assigned funds. These may be grouped into problems associated with selection of the type of ship, selection of the type of reactor, safety provisions, test construction, and test reactor. Possible problems in harboring a nuclear powered ship are discussed very briefly. (TTT)

38250 NS SAVANNAH CONTAINMENT INTEGRITY. ITS MEASUREMENT AND IMPROVEMENT. Taylor, James H. (Babcock and Wilcox Co., Lynchburg, Va.). Nucl. Appl., 1: 213-18(June 1965).

Leak-rate tests for the NS Savannah were initially conducted at pressures lower than those encountered in a maximum credible accident, requiring extrapolation to predict the release of radioactivity. Improved test procedures reduced extrapolation errors by making it possible to increase the test pressure to 60 lb/in.^{2} Leak rates determined by both absolute and reference methods showed close agreement. The most extensive Savannah containment tests are described. These tests showed that the most significant leakage was through the containment electrical penetrations. Replacement of the original penetration fittings with an improved design using hermetically sealed conductors is eliminating this leakage. Significant leaks were also detected at the seats of valves forming a single containment barrier. Installation of double valves and valves using seats with teflon inserts is eliminating this leakage. (auth)

38251 THE NERVA NUCLEAR ROCKET REACTOR PROGRAM. Esselman, W. H. (Westinghouse Electric Corp., Pittsburgh, Pa.). Westinghouse Engr., 25: 66-77 (May 1965).

Evolution of the NERVA (Nuclear Engine for Rocket Vehicle Applications) program since its inception in 1961 is traced, with descriptions and illustrations of nuclear rocket engine designs. The nuclear rocket engine achieves its thrust by heating hydrogen to temperatures in the 3000 to 4000°F range and expanding this gas through a nozzle. The operating cycle of a typical nuclear rocket engine is shown. Liquid hydrogen in the vehicle tank stored at −420°C is pumped to engine operating pressures by a turbopump. The hydrogen then passes through the tubes of a regeneratively cooled nozzle into the core, where it is heated to outlet temperatures. Passing through the nozzle, the hydrogen expands and accelerates to supply the engine thrust needed to push the rocket into space. A mockup is shown of the NERVA engine, which is 22 ft high and has a performance goal to provide 50,000 pounds of thrust. The reactor, which is a right circular cylinder ~3 ft in dia by 4 ft high enclosed within the pressure vessel, produces a thermal power of about 1000 Mw. The annulus between the reactor core and the pressure vessel is occupied by a beryllium neutron reflector, which contains the reactor control drums. Directly above the inlet end of the reactor is a radiation shield that shadows the engine components, vehicle, and payload, and protects them from excessive radiation doses and heat deposition. Problems encountered in the NERVA reactor design are also discussed. High operating temperatures in a potentially corrosive atmosphere, extreme variations in temperature across the reactor, and rapid temperature transients make this reactor design a formidable task. Graphite was chosen for the NERVA fuel element. Reactor testing is described, and possible future developments outlined. (TCO)

38252 DEVELOPMENT OF A TITANIUM PRESSURE VESSEL FOR NERVA. Snyder, C. R. (Aerojet-General Corp., Sacramento, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint AIAA Paper No. 65-590, 18p. $1.00. (CONF-650610-10). ORINS

From American Inst. of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs.

The necessity for a flight-weight reactor pressure vessel for the original NERVA engine brought together for the first time requirements which had been singularly important in other programs. This vessel was to function as a support for the reactor and as a container for the pressurized liquid-hydrogen propellant. To meet these requirements, the configuration selected needed good structural design, and the material chosen had to have a high strength, low weight, adequate toughness, and radiation-resistant properties. Titanium alloy 5Al–2.5Sn, ELI grade, was selected following a study of several candidate materials. Forming this material from a billet to the rough 50-inch diameter cylindrical shapes for the pressure vessel cylinder preceded final fabrication of the pressure vessel cylinder consisting of machining and hot stretching operations combined with welding. Subsequent hydrotesting of the completed cylinder and closure was successfully performed. Results from a materials testing program, covering the range of temperatures over which the material is expected to perform, are quite satisfactory. A satisfactory radiation effects testing program is all that is still needed to demonstrate the suitability of this material for NERVA application. (auth)

38253 FLUID-STATE CONTROL SYSTEMS FOR AEROSPACE NUCLEAR PROPULSION APPLICATIONS. Burton, G. T. Jr.; Farron, J. R.; Niehaus, D. J. (Bendix Corp., Southfield, Mich.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint AIAA Paper No. 65-618, 18p. $1.00. (CONF-650610-15). ORINS

From American Inst. of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs.

Control systems for nuclear propulsion must operate with high reliability in a combination of severe environments. Since the effects of these environments are virtually unknown and difficult to test for, fluid-state control systems offer a potential of upgrading the reliability of the entire system because they have no moving parts and a number of types have demonstrated ability for operating in severe environmental conditions. A summary of typical requirements and synthesis of selected fluid-state aerospace nuclear electric propulsion control system functions are presented to illustrate the application of this fluid-state technology. Computing and actuating methods, and concepts for fluid-state sensors and instrumentation are given. Included also is a list of steps required to provide fluid-state nuclear propulsion control systems for flight testing by the 1968-1970 period. (J.F.P.)

38254 IN-CORE TEMPERATURE CONTROL OF NRX REACTORS. Elmiger, R. A. (Westinghouse Electric Corp., Pittsburgh). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint AIAA Paper No. 65-598, 10p. $1.00. (CONF-650610-13). ORINS

From American Inst. of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs.

To obtain a maximum specific impulse from the nuclear-rocket engine, the reactor is run at as high a temperature as possible within the thermal limits of the core and its structural components. High-temperature thermocouples located within selected unfueled elements in the core of the reactor provide the necessary temperature sensing for control. Core design dictates that for any given axial plane through the reactor, the fuel is distributed to provide a flat radial and azimuthal temperature profile. Thus, a redundant array of thermocouples at the plane chosen for control can be used to improve accuracy of sensing and reliability. These temperature signals are sent to a logic system which averages them and provides for automatic rejection of any signal deviating beyond a preset limit from the generated average. The summation of this signal with a temperature demand in an integral plus proportional controller generates a power correction to the basic reactor flux-power control loop. In addition to this, thermal overrides to the power loop originating from other structural element temperatures are provided to limit temperature excursions resulting from possible malfunctions. Experimental results obtained from NRX-A2 and several KIWI reactor tests using in-core sensors has shown this method of control is feasible. (auth)

38255 THE EFFECTS OF HOT HYDROGEN PROPELLANT ON THE CRITICAL MASS OF GASEOUS NUCLEAR ROCKET CAVITY REACTORS. Latham, Thomas S. (United Aircraft Research Labs., East Hartford, Conn.); Herwig, Lloyd O. New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint AIAA Paper No. 65-564, 20p. $1.00. (CONF-650610-5). ORINS

From American Inst. of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs.

Hot high-pressure hydrogen propellant in large reflector-moderated, gaseous-fueled cavity reactors is shown to increase critical masses by a factor of two or more relative to the critical masses required when hot hydrogen is not present in the cavity. Thermal neutron-flux distributions within the cavity are shifted by energy up-scattering collisions between the hot hydrogen and the thermal neutrons flowing into the cavity from the reflector-moderator. For low-energy neutrons, the probability for these energy up-scattering collisions is enhanced by the thermal motion of hydrogen at high temperatures. Critical masses are affected largely in proportion to changes in the flux-weighted, fuel-region cross sections, since the neutron-flux distribution in the reflector-moderator is not strongly dependent upon cavity conditions. Calculations were made for hydrogen pressures between zero and 1500 atm, for hydrogen temperatures of 20,000 and 60,000 K, for Pu-239 and U-233 fuels, and for two different reflector-moderator configurations. It was found that critical-mass increases were less drastic for U-233 than for Pu-239 due to the presence of fission resonances for U-233 in the 1.0 to 10.0 ev range. (auth)

38256 A PLASMA CORE NUCLEAR ROCKET UTILIZING A MAGNETOHYDRODYNAMICALLY-DRIVEN VORTEX. Johnson, Kurt P. (Douglas Aircraft Co., Inc., Santa Monica, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint AIAA Paper No. 65-583, 34p. $1.00. (CONF-650610-8). ORINS

From American Inst. of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs.

A concept for a plasma core nuclear rocket is presented which utilizes Lorentz forces to drive a vortex. The control of diffusion processes by the vortex isolates a zone of fuel from zones of propellant within the vortex. The primary propellant flows by-pass the fuel in the axial direction, receiving heat by radiant transport. A parametric study of fuel containment conditions is presented for a simplified two-dimensional model, including radiant transport. The study indicates that laminar vortex flow would provide containment of a critical mass of fuel. The pressure level required to achieve criticality decreases with cavity radius, and tends to impose a requirement for radii exceeding 1 m. Electric power requirements for driving the vortex are modest compared to reactor power levels. Typical reactor power levels exceeding 50,000 Mw provide thrusts exceeding one million pounds at a specific impulse of 2500 sec. (auth)

38257 NUCLEAR ENGINE CLUSTERING CONSIDERATIONS. Langley, R. W.; Woyski, Jan S. (Douglas Aircraft Co., Inc., Santa Monica, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1965 Preprint AIAA Paper No. 65-611, 15p. $1.00 (CONF-650610-18). ORINS

From American Inst. of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs.

Some considerations involved in the clustering of solid-core nuclear engines have been examined parametrically in order to determine their importance and to indicate the effect of system tradeoffs on vehicle performance. These include neutronic-coupling effects, structural requirements, shielding, and reliability. A potentially important consideration is the propulsion system reliability. To satisfy typical propulsion reliability requirements for a manned mission, it is shown that clustering with engine-out capability is very effective in relaxing the reliability constraints of the individual engines. For example, for a Mars landing mission, engine-out capability on the first three stages results in an initial weight-out-of-orbit penalty of only 15%, but reduces the individual engine reliability requirement from 0.992 to 0.96. This can represent a significant difference in engine-development effort. (auth)

38258 A TECHNIQUE FOR THE ANALYSIS OF THE RADIOLOGICAL HAZARDS OF NUCLEAR ROCKET FLIGHT OPERATIONS. Brown, William S. (Westinghouse Electric Corp., Pittsburgh). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint AIAA Paper No. 65-599, 14p. $1.00. (CONF-650610-14). ORINS

From American Inst. of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs.

The safety considerations of nuclear powered rocket flight operations are analyzed to assure that no unacceptable hazards will arise in the event that a failure occurs prior to mission completion. Digital computer programs are developed for use in such analyses to predict the magnitude of the radiological hazards to the earth's populace resulting from such a failure. Results of the application of these computer programs to orbit start missions of a NERVA powered space vehicle are presented. (auth)

Research and Test Reactors

38259 (AERE-M-1498) CALIBRATION OF THE DAPHNE COARSE-CONTROL ARMS BY MEANS OF THE PULSED-NEUTRON TECHNIQUE. Rampling, M. W. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1965. 47p. Dep.; $1.20(BIS); 6s.(HMSO).

The results of calibration of DAPHNE coarse-control arms by means of the pulsed-neutron method are compared with a calibration curve produced by a doubling-time technique. A theoretical investigation using a 4-energy-group diffusion program to simulate the DAPHNE system gave the degree of reliability inherent in the normal pulsed-neutron technique. (auth)

38260 (ANL-6990) A MANUAL OF REACTOR LABORATORY EXPERIMENTS. Daavettila, D. A.; Gilbert, W. F.; Lawyer, L. L.; Ruzich, K. C.; Spalek, J.; Sturm, W. J. (Argonne National Lab., Ill.). Jan. 1965. Contract W-31-109-eng-38. 687p. Dep. mn; CFSTI $10.00 cy, $3.00 mn.

Training experiments in nuclear reactor physics, engineering, and technology are presented. Each experimental presentation included begins with a simple description of the experiment in its theoretical and practical aspects. The specific organization related to the method of application by the Institute Staff; thus, for example, it includes a set of discussion questions which become part of the briefing which precedes the experiment. An additional novel

feature of this presentation is the inclusion of a typical set of results obtained by students during the performance of the experiment. (M.O.W.)

38261 (APED-4548) GETR CONTAINMENT BUILDING VENTILATION SYSTEM. Pomeroy, D. L. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Sept. 1964. 30p. (65APE7).

The ventilation system provides fresh air to the containment building and provides for the safe discharge to the atmosphere of any radioactive gases that may be released from the reactor or experiments. The ventilation stack monitoring equipment and operation procedures are discussed. The methods used for calculating the diffusion of gases from the ventilation stack and the results obtained are given. The release of particulate and unidentified and identified gases is discussed with relation to the GETR operating license and maximum permissible concentrations. The value of controlled ventilation clean-up procedures and of gas identification is shown. (auth)

38262 (DP-964) CORROSION OF EQUIPMENT IN THE HEAVY WATER COMPONENTS TEST REACTOR. McKibben, J. Malvyn (Du Pont de Nemours (E.I.) and Co., Aiken, S. C. Savannah River Lab.). June 1965. Contract AT (07-2)-1. 30p. Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

The corrosion experience at the Heavy Water Components Test Reactor is evaluated after three years of service. Within the moderator-coolant system, corrosion caused no operating problems or equipment failures. Adherent black oxide covered all mild steel surfaces in the moderator-coolant system, and no significant pitting was observed. (auth)

38263 (GAMD-5958) GENERAL ATOMIC IN-PILE LOOP PLATEOUT ANALYSIS CYCLES 35 THROUGH 41, JULY–SEPTEMBER 1963. Zumwalt, L. R.; Busch, D. D. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Apr. 17, 1963. Contract AT(04-3)-167. 32p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The GAIL (General Atomic In-pile Loop) in the GETR is studied for determination of fission products deposited, in piping and on plateout sleeves and traps, during reactor cycles 35 through 41. (T.F.H.)

38264 (GEAP-4781) PLUTONIUM SUBCRITICAL EXPERIMENT PROGRAM. Program Summary and Second Quarterly Report, October 1–December 31, 1964. Carver, J. G. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 8, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 15p. (EURAEC-1311). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Accurate prediction of low-energy resonance absorption rates in the fuel may require detailed treatment of the perturbation of the resonance flux in the water surrounding a rod, as well as consideration of the fact that a single oxygen collision (within the rod) is not sufficient to scatter a neutron out of the ^{240}Pu resonance. Approximately 400 kg of the fuel, as specified, will be sufficient to construct lattices with multiplications of 0.95 for water/fuel ratios below 2/1, and with large central zones of essentially constant spectrum. Regulation of pressure within the vessel can be accomplished efficiently by using a low-flow, high-pressure pump. (auth)

38265 (HW-61236(Suppl.6)(Rev.) PLUTONIUM RECYCLE TEST REACTOR, FINAL SAFEGUARDS ANALYSIS, SUPPLEMENT 6 REVISED LIMITS: ANALYSIS OF UNIFORMLY-ENRICHED CORE. Hanthorn, H. E.; Winegardner, W. K.; Wittenbrock, N. G. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Dec. 1964. Contract AT(45-1)-1350. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The temperature coefficients of reactivity of uniformly enriched plutonia–urania fuels in PRTR are calculated. The heat transfer flux and tube power limits applicable to this type fuel loading are derived. (T.F.H.)

38266 (HW-84608(p.31-53)) ANALYSIS OF MTR CYCLE 108— LOW-EXPOSURE PLUTONIUM CORES. Regimbal, J. J. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Calculations of the statics and burnup of the two full fuel loadings that comprised the MTR Cycle 108 experiment are reported. The first loading comprised 3.69 kg of Pu, and was tested at nearly zero power; the second loading, denoted the "power core," contained about 0.25 kg less Pu and was burned for 262 Mwd at 5, 20, 25, and 30 Mw. The fuel was in the form of Pu–Al plates having 4.3 isotopic % ^{240}Pu. The statics of both cores at the beginning of life are analyzed. The reactivity changes in the power core during burnup are measured. (T.F.H.)

38267 (HW-84608(p.67-76)) MIGRATION AREA AND MODERATOR REACTIVITY COEFFICIENTS MEASURED DURING THE EBWR CRITICAL EXPERIMENTS. Uotinen, V. O. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Coefficients of reactivity for moderator level changes have been measured in the PRCF for a loading of 1.5 wt % PuO_2–UO_2 fuel moderated by H_2O. The center-to-center lattice spacing of the fuel rods corresponds to a volume ratio of H_2O moderator to PuO_2–UO_2 fuel of 2.71. This ratio is the same as that which will be used for a similar loading in the EBWR except the geometrical arrangement will be different. The moderator level coefficients of reactivity allow the migration area of the core to be determined. The reactivity worth of the top reflector, which is effectively infinitely thick, is 22.6 ± 0.4¢. The migration area was found to be 22 ± 2 cm^2. (auth)

38268 (HW-84609(p.10.1-18)) PLUTONIUM RECYCLE TEST REACTOR OPERATION AND RELATED FUNCTIONS. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Operation is described and support activities such as core design, thermal hydraulic studies, B shim studies, fuel cost estimates, safety of mixed PuO_2-UO_2 fuels, studies of rupture loop vibrations, fretting corrosion studies, studies of mechanical shim for PRTR, and dissolution of PuO_2–UO_2 are described. Decontamination of PRTR jumpers is reported along with ceramic fuel washout tests. Investigations of stress cracking in PRTR gaskets, PRTR boiling H_2O, flow of steam-water mixtures, and heavy-water moderated reactors are reported. (J.R.D.)

38269 (IDO-17054) ANALYSIS OF FAST TRANSIENT REACTIVITY EFFECTS IN THE SPERT I WATER-MODERATED, UO_2-FUELED CORE. Spano, A. H.; Houghtaling, J. E. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). May 1965. Contract AT(10-1)-205. 57p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

From short-period power excursion tests of a UO_2-fueled core in Spert I, two principal reactivity feedback effects have been isolated: A prompt negative Doppler effect associated with the heating of the fuel, and a slightly delayed positive effect associated with transient bowing of the fuel rods. An analysis is given of these two mechanisms, which characterize the kinetics of this core for the case of large reactivity insertions. Through the analysis, an expression relating the Doppler reactivity effect to the energy released during an excursion is derived and applied to power excursion tests in which fuel rod bowing was eliminated. A comparison of the calculated and experimental results shows good agreement over the range of the experimental data. The form of the temperature dependence of the Doppler effect is investigated further by considering the case of the Doppler coefficient varying with absolute temperature as T^{-n}. The investigation shows consistent agreement between calculations and the experiment for $n = \frac{1}{2}$, while several other dependencies give results differing significantly from the experiment. A more rigorous development of the Doppler reactivity feedback model is discussed. It does not compromise the usefulness or validity of the results obtained by the less rigorous technique. From an analysis of power excursion tests in the unconstrained core, the fuel rod bowing effect is indirectly determined and shown to be almost entirely due to the bowing of the outer ring of fuel rods. The calculated results for transient tests with initial asymptotic periods of 27, 14, and 9.7 msec indicate corre-

sponding maximum fuel rod bowing effects of about 45, 55, and 75¢, respectively. (auth)

38270 (IDO-17102) HYDRAULIC STUDIES OF SPERT REACTOR CORE COMPONENTS. Koenig, J. F. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Mar. 30, 1963. Contract AT(10-1)-205. 36p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A compilation is presented of the hydraulic calculations and experimental flow studies that have been performed on various SPERT flat-plate fuel assemblies and core filler components. A brief description of the calculation and experimental techniques is given. The calculated overall pressure drop-flow relationship for each assembly is presented and compared, when applicable, with the experimentally obtained pressure drop-flow relationship. In addition, the experimental channel-pressure distribution and channel flow distribution are presented. (auth)

38271 (IDO-24044) DESIGN CRITERIA FOR GAS-COOLED LOOP IN THE ADVANCED TEST REACTOR. (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div. and Ebasco Services, Inc., New York). May 1963. Contract AT(10-1)-1075. 126p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Design criteria are presented for a proposed gas-cooled in-pile loop in the Advanced Test Reactor at NRTS, with particulars on the loop itself, the out-of-pile components, in-pile section handling equipment, test-specimen handling, specimen casks, nuclear criteria, and instrumentation and controls. (T.F.H.)

38272 (JUL-Bibl-9) GEPULSTE REAKTOREN. (Pulsed Reactors). Krueger, F. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). July 1964. 18p. Dep.(mn).

Bibliographic references on pulsed reactors in general, pulsed TRIGA reactors, TREAT, SPRF, HPRR, and GODIVA were compiled. (J.S.R.)

38273 (KFK-303) PULSED SOURCE AND NOISE MEASUREMENTS ON THE STARK-REACTOR AT KARLSRUHE. Edelmann, M.; Kussmaul, G.; Meister, H.; Stegemann, D; Vaeth, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). May 1965. 32p. (CONF-650504-40).

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

For the determination of kinetic reactor physics parameters, such as the prompt neutron decay constant α, the neutron generation time, and related quantities, different experimental methods can be applied. The pulsed neutron source technique and the analysis of statistical phenomena due to branching processes in neutron chains within the reactor are the most powerful tools for these investigations. Experiments and a comparison of results which were measured under exactly the same loading and reactivity conditions in STARK first by the pulsed neutron source technique and then by three different statistical methods are presented. The statistical methods are: the Rossi-α-experiment, the analysis of counting statistics, and the frequency analysis of noise. (M.O.W.)

38274 (LA-DC-6972) POTENTIAL FOR TESTING MOLTEN PLUTONIUM FAST REACTOR FUELS IN A THERMAL TEST REACTOR. Ragan, G. L.; Busey, H. M. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 3p. (CONF-650602-17) Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

The 5-Mw Omega West Reactor (OWR) may be used to irradiate molten Pu fuel alloys. Nuclear calculations were made for three Pu fuel alloys in a simplified model of OWR. Average specific powers, power densities, and power ratios were obtained. (D.L.C.)

38275 (ORNL-TM-1048) GCR-ORR LOOP 2 DESIGN. Zasler, J.; Gnadt, P. A.; Huntley, W. R.; Kress, T. S.; Roller, H. C. (Oak Ridge National Lab., Tenn.). June 1965. Contract W-7405-eng-26. 119p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

A pilot-plant-scale in-pile loop facility was developed for studying the performance of unclad fuel elements and the effects on a reactor system of operating with high-temperature gaseous coolants contaminated with fission products. The components of the facility are the in-pile section, which holds the fuel element and has two gas entry passages and a common exit passage, a regenerative heat exchanger, an evaporative cooler, an electric heater, a filter, two compressors, and a bypass purification system. Design criteria for the loop were based on calculated and measured performance data on loop components and auxiliary equipment, on shielding and activity analyses, and on safety studies. (auth)

38276 (TRG-Report-957) RATIO OF FAST- TO THERMAL-NEUTRON FLUX IN HOLLOW 150g FUEL ELEMENT FACILITIES IN DIDO AND PLUTO. Martin, W. H.; Clare, D. M. (Reactor Group, United Kingdom Atomic Energy Authority, Culcheth (England)). Jan. 14, 1965. 6p. Dep.; BIS, $0.30; HMSO, 1s. 6d.

The variation of the ratio of fast- to thermal-neutron flux in a hollow 150 gm fuel element in DIDO or PLUTO, with mean weight of ^{235}U in the element during the irradiation, obtained by direct measurement of fast- and thermal-neutron doses, is significantly less than previously indicated by measurements made at low reactor power. Therefore, fast-neutron doses obtained by measuring thermal-neutron dose and using the low-power relationship are lower than directly measured fast-neutron doses by up to 20% at 30% mean fission burn-up of ^{235}U. (auth)

38277 RC-1 REACTOR POWER OUTPUT TO BE INCREASED. Comit. Nazl. Energia Nucl., Notiziario, 11: No. 4, 34-7(Apr. 1965). (In Italian)

The modification work to be done to increase the power output of the RC-1 Reactor to 1 Mw is discussed. The tentative design work is described. (auth)

38278 NEUTRON SPECTRA OF THE REACTOR IRT-1000 IN SOFIA. Khristov, V.; Stanolov, A. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk, 13: 5-12(1965). (In Bulgarian)

The effective neutron temperature of the reactor IRT-1000 in Sofia was determined by two independent methods (the method of transmission and the method of reactivity). The value 375°K has been obtained. The constant λ, connecting the thermal spectrum of Maxwell with the spectrum of Fermi, was determined. The results obtained by the method of two independent resonance detectors and the method of the cadmium ratio are in good agreement. In the center of the pile core $\lambda = 0.056$. The integral fast neutron spectrum in the interval from 2.7 to 12.18 Mev was determined by means of 7 threshold detectors. (auth)

38279 DIPOLE EFFECT OF PILE OSCILLATOR. Kawai, Toshio (Central Research Lab., Hitachi, Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 217-24(June 1965).

A higher order effect was found in the transfer function measurements on the Argonaut Reactor at the Argonne National Laboratory. The gain and phase were altered when the direction of rotation of the pile oscillator was reversed. This effect can be explained by considering higher spatial modes and the dipole characteristics of the oscillator. The dipole represents the finite dimensions of the pile oscillator, which is a corrective term when the monopole effect is dominant. (auth)

38280 MEASUREMENTS OF SUBCRITICAL REACTOR NOISE SPECTRA BY CORRELATION METHOD. Nomura, Tsutomu; Yamaki, Kozo (NAIG Nuclear Research Lab., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 236-7(June 1965).

The subcritical reactor noise spectra were obtained by rod drop while the power was slowly decreased with a constant period associated with the long delayed neutron decay constant. The correlation technique was used in order to eliminate the obstruction of chamber noise. The technique

is favorable to determine the shutdown margin in the subcritical reactor noise spectra measurements. (J.F.P.)

38281 EXAMINATION OF COLD NEUTRON SPECTRA FROM THE THERMAL COLUMN OF THE WWR-M REACTOR. Maistrenko, A. N. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 10: 610-14(June 1965). (In Ukrainian)

The physical parameters of a mechanical chopper and mechanical monochromator designed for work in the cold neutron region are described. Neutron spectra from the horizontal canal of the reactor thermal column with various geometry are presented, and their temperatures are evaluated. (auth)

38282 STATUS REPORT ON THE WR-1 REACTOR AND PLANS FOR ITS USE IN THE AECL RESEARCH AND DEVELOPMENT PROGRAM. Robertson, R. F. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Toronto, Canadian Nuclear Association, 1965, Preprint No. 65-CNA-205, 15p. (CONF-650515-10). ORINS

From International Conference and Exhibition of Canadian Nuclear Assn., Quebec.

The WR-1 Reactor now under construction near Winnipeg uses heavy water as a moderator, an organic fluid as a coolant, and enriched UO_2 for its fuel. The reactor has some special features which make it a good material test reactor. A description of the reactor is presented. (J.F.P.)

38283 REMOTE HANDLING DEVICE HAVING A PAIR OF JAWS. Chatelus, Michel (to Commissariat a l'Energie Atomique). British Patent 990,954. May 5, 1965. Priority date Feb. 12, 1963, France.

The remote-handling device patented permits an article to be gripped, moved from place to place, tilted, or pivoted through any angle up to a semicircle. The apparatus includes a supporting rod, a pinion arranged for rotation about its axis at one end of the supporting rod, a pair of relatively movable jaws a first one of which is rigidly secured to the pinion, and a toothed rack meshing with the pinion and arranged for movement relative to the supporting rod for controlling the pivotal movement of the jaws. The device is particularly suitable for handling objects immersed in a swimming-pool-type reactor. (A.G.W.)

38284 DEVICE FOR ADJUSTING THE POSITION OF FUEL OR REFLECTOR ELEMENTS IN THE TANK OF A NUCLEAR REACTOR. Jouin, Jacques (to Commissariat a l'Energie Atomique). German Patent 1,191,050. Apr. 15, 1965. Priority date Apr. 13, 1962, France.

The device described makes it possible to place in position a series of fuel elements according to the nodes of a lattice having variable pitch inside the tank of a swimming-pool reactor. The device consists of a frame with four sides and with opposite sides parallel. A series of cross-members are positioned at right angles to two opposite sides and they rest through the intermediary of means that permit the displacement of the cross-members in parallel relation to the first sides, and stirrups supporting the elements and adapted to move along the cross-members. At least one abutment member is mounted on each cross-member and made fast for translational motion with the cross-member. The abutment member is made fast for rotation with a common driving shaft mounted at right angles to the cross-members and provided with a projecting part. The projecting part has different orientations according to the cross-members. A trolley is adapted to move at right angles to the cross-members and is brought into abutment with the projecting parts and caused to drive the corresponding cross-members according to the predetermined orientation of the projecting parts, which was established by means of the shaft. (Gmelin Inst.)

WASTE DISPOSAL AND PROCESSING

See also BIOLOGY AND MEDICINE — Ecology.
CHEMISTRY — Radiochemistry.
CHEMISTRY — Separation Processes and Procedures.
HEALTH AND SAFETY.

Refer also to abstracts 36535 and 36702.

38285 (BNWL-76) RESEARCH AND DEVELOPMENT ACTIVITIES—FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, January–March 1965. Platt, A. M. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1965. Contract AT(45-1)-1830. 43p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

Leaching test results on high-level phosphate glass show that dry storage is essential for maintaining low leachability, moist air being more deleterious to the glass surface than immersion in water. Ground water at pH 7.8 was found to yield leach rates about twice those obtained with double-distilled water. Solubility measurements on the phosphate mixtures of synthetic fission product and process oxides containing 3, 10, and 50% fission products were completed. Comparative measurements for a sulfate-free waste show that over the desirable phosphate range there is little effect produced by the presence of sulfate. Examination of the hot spray calciner revealed extensive corrosion of the Inconel wall, with some apparent stress cracking. Ru does not seem to be preferentially absorbed on the calciner off-gas line. Evolution of SO_3 from melts composed of Purex 1WW waste and phosphate (M/P = 2.3) was greater than from Purex 1WW-B_2O_3 melts. The percentage of sulfate retained in the 1WW-phosphate melts when held at 950°C for 3 hr decreased as the concentration of sulfate was increased. The fusion point of melts containing added phosphate increased from 940°C at an M/P of 1.7 to 1040°C at an M/P of 3.1. Cooled melts changed from glassy to rock-like and nonhomogenous as the M/P was increased. A Pt-Inconel 600-Pt sandwich suffered catastrophic attack when exposed in a Purex 1WW melt at 1100°C but did not at lower temperatures. Addition of solid fluxing agents to the spray calciner-melter as a means of glass formation was found to be feasible in a run with liquid 1WW and a separate addition of borate-containing glass balls. Fabrication of the phosphate glass system for waste solidification is underway. Fabrication of the spray calciner-melter system is nearing completion. The waste solidification evaporator and acid fractionator has undergone testing in pot calcination runs. Results of sealing and weld joint tests on stovepipe waste container heads indicate that such heads can be used to simplify fabrication and reduce costs. Studies are continuing on crystallization of sulfates from acid condensates generated in glass making processes. A scheme which employs scavenging, ion exchange, and adsorption was investigated for the treatment of intermediate level laboratory-type waste. A pilot scale run with a horizontal plate filter and anion and cation exchange columns removed all radioisotopes except ^{106}Ru from a steam stripped condensate waste stream to below MPC_w values. (J.R.D.)

38286 (HW-SA-3604) UNIQUE PROBLEMS OF RADIOACTIVE WASTE SOLIDIFICATION. Interim Report. Cooley, C. R.; Schneider, K. J. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 3, 1964. Contract AT(45-1)-1350. 70p. (CONF-650603-2) Dep. mn; CFSTI, $2.00 cy, $0.50 mn.

From Joint Meeting of the American Institute of Chemical Engineering and the British Institution of Chemical Engineers, London.

A pilot plant has been constructed to demonstrate the technical and economic feasibility of converting liquid radioactive wastes to solids for immobilized permanent storage. Special consideration is given to the design problems associated with converting radioactive liquids to solids ranging from powders and calcines to ceramics or glasses. Temperatures as high as 1200°C require design precautions to contain volatile components, to obtain proper materials of construction and to assure non-hazardous operating conditions. Radioactive self-heating and storage characteristics of wastes require design of processing and storage conditions to circumvent overheating. Actual equipment is illustrated, and precautions necessary to cope with processing conditions in a routine and safe manner are discussed. (auth)

38287 (NDL-TM-20) CONCENTRATION OF RADIOACTIVELY-CONTAMINATED POTASSIUM TETRABORATE TETRAHYDRATE (PTB) WASTE SOLUTIONS. Goff, David L.; Bloore, Ernest W.; Crisco, Carl (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). May 1965. 69p.

The ability of the Radioactive Liquid Waste Treatment Facility was demonstrated in successfully processing radioactively contaminated aqueous solutions of potassium tetraborate (PTB). Feed solutions contained an average of 50,000 ppm PTB and 10^{-5} to 10^{-2} μC/ml of gross beta activity. Evaporator bottoms approached theoretical saturation while the effluent remained essentially free of chemical and radiological contaminants. (auth)

38288 A SMALL INSTALLATION FOR THE TREATMENT OF RADIOACTIVE SEWAGE. Schulze-Rettmer, R.; Rattay, K. H. (Kernforschungsanlage, Julich, Ger.). Atompraxis, 6: 320-2(June 1965). (In German)

For digesting the radioactive sewage effluent from a radiological hospital, a small sewage-treatment device was installed in which the biological material of the waste water was chemically oxidized. This was desirable in order to assist the decontamination process. After homogenizing the solids, the sewage was warmed to 80°C and potassium peroxodisulfate was added. The addition of acid was advantageous. The efficiency was similar to that of good biological sewage treatment plants. The amount of sludge occurring in the waste water was small. Both sludge and water may afterwards be decontaminated in a further treatment system. The oxidized components were sterilized, and after neutralization were no longer toxic. (auth)

38289 ENVIRONMENTAL HAZARD OF RADIOACTIVE WASTES. Ledbetter, Joe O. (Univ. of Texas, Austin). J. Sanit. Eng. Div. Am. Soc. Civil Engrs., 91: 59-66(Feb. 1965).

Hazards involved in the following three methods of radioactive waste disposal are discussed: dilution to acceptable environmental levels; storage for decay; and reclamation to useful products. The wastes must variously be handled, transported, processed, and stored and, in addition, the accidental spills and releases must be cleaned up and isolated. All of these operations involve the possibility of hazardous radiation exposures. (TCO)

38290 WATER POLLUTION FROM VARIOUS SOURCES INCLUDING URANIUM MINING OPERATIONS. Hilliard, T. R. (Ontario Dept. of Energy and Resources). Toronto, Canadian Nuclear Association, 1965, Preprint No. 65-CNA-219, 9p. (CONF-650515-2). ORINS

From International Conference and Exhibition of Canadian Nuclear Assn., Quebec.

The control of contamination of water supplies by wastes from various industries is discussed. A study of expenditure for pollution control and related research in United

States chemical companies showed that expenses over the last several years averaged ½ of a percent of net plant and equipment valuation, and that pollution control expenses amounted to about 0.2 percent of net sales. The cost to prevent water shortage, to control waste, and to regain a lost position will be high. Nature performs the first act of replenishment by a perpetual recycling system and it is our responsibility to aid nature so that use and re-use of water can be achieved for our modern way of life. Water will not remain the cheap commodity that it has been in the past. Competition for its use will increase, and pollution control will be accepted by the public. (auth)

GENERAL AND MISCELLANEOUS

38291 (BNL-8825) HOMOLOGY AND DIVERGENCE IN GENETIC MATERIAL OF SALMONELLA TYPHIMURIUM AND ESCHERICHIA COLI. Demerec, M. (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 12p. (CONF-650901-1). Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

From Symposium on Evolving Genes and Proteins, New Brunswick, N. J.

No well substantiated case of chromosomal rearrangement has been discovered by comparison of the genetic maps of S. typhimurium and E. coli, although more than a hundred genes have been mapped in each organism. Thus it appears that in the evolutionary differentiation between these two species rearrangements have occurred much less frequently than in Drosophila and, presumably, other higher organisms. An explanation of the phenomenon is suggested by the finding that in S. typhimurium and E. coli, genes controlling related functions are often clustered together. Seventeen such clusters, distributed along the genome, have been found in S. typhimurium. If a cluster is to persist, the gene arrangement it represents must offer some selective advantage to the organism, in which case chromosomal rearrangements, which are likely to break up clusters, would be selected against. Therefore the high degree of homology of gene arrangement observed in the two species can be explained by assuming that a common progenitor also had clusters, which were responsible for retention of its gene arrangement in species derived from it. A technique was developed for determining the frequency of incorporation of a genetic marker derived for E. coli into the homologous region of the S. typhimurium chromosome. In general that frequency is considerably lower than the frequency of incorporation of the corresponding S. typhimurium marker. This finding is interpreted as an indication of structural divergence between the chromosomes of the two species. In view of the unexpectedly high degree of correspondence as far as gene order is concerned, it is inferred that the divergence detected by the incorporation studies is due to differences at the molecular level rather than to differences in gross chromosomal structure. (auth)

38292 (BNL-9257) LASER FLASH TUBE TRIGGERING SYSTEM. Stephani, D. (Brookhaven National Lab., Upton, N. Y.). June 3, 1965. Contract AT-30-2-GEN-16. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A circuit is designed to fire Xe flash tubes used in a laser systems. An Al reflector, which completely encircles the laser crystal and the flash tubes, is grounded. A small wire loop is wrapped around the flash tube at the ground, just above the grounded electrode. This wire is coupled to the high-voltage pulsed electrode through 50 pf. This expedient produces reliable firing of the flash tubes for high-voltage supplies of 800 to 2800 v. In the configuration used, four flash tubes are spaced uniformly around the laser crystal, and the described circuit is used to fire all four of the tubes. (T.F.H.)

38293 (BNWL-113-2) PLUTONIUM ABSTRACTS. Volume 5, No. 2. (Battelle-Northwest, Richland; Wash. Pacific Northwest Lab.). Mar. 10, 1965. Contract AT (45-1)-1830. 11p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

Fifteen abstracts are presented on new developments in plutonium technology. They are arranged under the following headings: chemistry, metallurgy and ceramics, physics, and reactor technology. (D.L.C.)

38294 (BNWL-113-4) PLUTONIUM ABSTRACTS. Volume 5, No. 4. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 28, 1965. Contract AT (45-1)-1830. 18p. Dep. mn; CFSTI, $1.00 cy, $0.50 mn.

A total of 29 abstracts is presented on new developments in plutonium technology. They are arranged under the following headings: chemistry, health and safety, metallurgy, physics, and reactor technology. (D.L.C.)

38295 (CONF-650621-1) USE OF BULK CORE MEMORY IN IMPROVING TIME SHARING EFFICIENCY. Reilly, E. D. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract W-31-109-eng-52. 7p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

From Special Technical Meeting on Use of Remote Access, Time Sharing Computer Systems, Schenectady, N. Y.

The problem of deterioration of the computer efficiency in the "swapping" of jobs between the main memory and the auxiliary storage device in computer time sharing is considered. Efficiency comparisons are made for drum and bulk core memory devices and three computer classes (GE 625, CDC 6600, and CDC 6800). It is shown that the use of a bulk core memory results in high efficiency and a small time quantum. (D.L.C.)

38296 (IS-T-14) TABLES OF ELLIPTIC INTEGRALS (thesis). Nellis, William Joel (Ames Lab., Iowa State Univ. of Science and Tech.). May 1965. Contract W-7405-eng-82. 46p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The tables present a method of evaluating elliptic integrals of the first and second kinds by means of the R function, a hypergeometric function of several variables. The general method is to reduce an integral of elliptic type to an R function by means of given integral formulas. Formulas for complete or incomplete integrals are then used to reduce the R function to a linear combination of two standard R functions and an algebraic function. The two standard functions, R_K and R_E (in the complete case) or R_F and R_G (in the incomplete case), are normal elliptic integrals of the first and second kinds. Numerical values of the normal integrals over a limited range are given. Elliptic integrals of the third kind (as well as many other integrals) can also be expressed in terms of the R function, but tables for reduction and numerical evaluation of integrals of the third kind are not included. (auth)

38297 (ORNL-3655) ON THE RADICAL OF A HEMIRING (thesis). LaTorre, D. R. (Oak Ridge National Lab., Tenn.). July 1965. W-7405-eng-26. 50p. Dep. (mn); $3.00(cy), 1(mn) CFSTI

Submitted to Tennessee Univ., Knoxville.

Several concepts of radicals in a hemiring are investigated. A study of Brown-McCoy radicals is presented. In so doing, certain results concerning the Jacobson radical of a hemiring are pointed out. It is proven that the Jacobson radical can be characterized as the intersection of a certain class of k-ideals. It is proven that if the semiring S is actually a ring, then the Jacobson hemiring radical of S coincides with the Jacobson ring radical of S. Several results are given concerning the Jacobson radical and subdirect sums of semirings. (M.O.W.)

38298 (SC-DC-65-1428) APPROXIMATE SOLUTIONS OF SYSTEMS OF NON-LINEAR EQUATIONS. [Greer, C. L.] (Sandia Corp., Albuquerque, N. Mex.). [May 1965]. Contract AT(29-1)-789. 12p. (CONF-650527-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Association for Computing Machinery, Rio Grande Chapter Meeting, Phoenix, Ariz.

A technique for solving non-linear algebraic and transcendental equations is presented. It is applied to the general n-dimensional problem $F(X) = 0$. The use of the technique is illustrated in a non-linear least-squares data fitting problem. (M.O.W.)

38299 (SC-RR-65-212) A SELF-ORGANIZED SYSTEM CALLED MICKEY MOUSE. A Research Report Covering Year Ending March 1964. Browning, Iben (Panoramic Research, Inc., Palo Alto, Calif.). Apr. 1964. Contract AT(29-1)-789. 40p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A simulated "neural net" was operated on large computers. In this net, quasi-random interconnections of

neuroids (i.e., simulated neurones) are made through synapsoids (simulated synapses). The latter are the sites which are modifiable. The network has feedback through an "external" function generator. The system as a whole has demonstrated limited "ability" to organize itself, to learn and forget, to repair itself, and in general to exhibit "behavior." It responds to "pain-like" inputs. Future experiments are suggested. (auth)

38300 (SC-TM-65-19) SEMIAUTOMATIC BUBBLE CAMERA FOR CONTRAVES CINETHEODOLITE. Larson, B. L. (Sandia Corp., Albuquerque, N. Mex.). May 1965. Contract AT(29-1)-789. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI

For safety reasons and convenience of operation, it was necessary to modify the bubble level camera on the Contraves cinetheodolite. This modification has changed the operation from manual to semiautomatic. (auth)

38301 (TID-85(4th Rev.)) REPORT NUMBER SERIES USED BY THE DIVISION OF TECHNICAL INFORMATION IN CATALOGING REPORTS. Fourth Revised Edition. Mayfield, Hannah B.; White, Helen W.; Rosser, Phillip W. (comps.) (Division of Technical Information Extension, AEC). Sept. 1964. 150p. Dep.; CFSTI, $4.00 cy.

Listings are presented of report series codes identified with the corporate or issuing organization, and of the organizations followed by report series each has used. Details of report numbering systems used by some of the organizations are also given. (D.L.C.)

38302 (TID-21641) HUMAN CHROMOSOME ANALYSIS BY A SEMI-AUTOMATIC SYSTEM. Joint Interim Progress Report, February 19, 1965. Neurath, Peter W. (Research and Advanced Development Div., AVCO Corp., Wilmington, Mass.); Falek, Arthur (New York State Psychiatric Inst., New York). Contracts AT(30-1)-3400 and AT(30-1)-3381. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress is reported in studies on computer processing of chromosomes. Success is reported in taping chromosome spreads digitally, in counting good non-overlapping chromosomes, and in classifying by length and other criteria. Some serious problems were encountered in terms of what constitutes a spread with good non-overlapping chromosomes, in the actual resolution of the scanner. The percentage of spreads with non-overlapping chromosome is now too small to be economically useful for large scale studies. Hence, over-lapping chromosome spreads must be successfully analyzed in proposed future computer programs. Considering each chromosome to be a black shape on a white background is inadequate for most actual spreads. Some portions of chromosomes, particularly the centromeres, often stain rather poorly, so that each chromosome is not a continuous unit. Therefore a program which identifies the chromosome outlines of a spread as contour lines of equal grey level, particularly if the same level of grey is used for all chromosomes in a spread, is liable to consider one chromosome as two or more. (C.H.)

38303 (TID-21898) A STUDY OF TRANSISTOR HIGH-SPEED SCHMITT-TRIGGER CIRCUITS. Scientific Report No. 12. Alspaugh, G. R.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Nov. 1, 1963. For Oak Ridge National Lab., Tenn. Nov. 1, 1963. Contract W-7405-eng-26; Subcontract 2160. 80p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Limitations on the switching speed of a conventional Schmitt-trigger circuit were studied. A review of the literature indicated that the fastest Schmitt-trigger circuit available operated at a maximum speed of 10 mcps and had an output wave form that resembled a sine wave. After the theory of the physical operation of transistors when acting as switches was reviewed, several problems associated with high speed switching circuits were outlined, and possible approaches to the solutions of these problems were suggested. Two high speed Schmitt-trigger circuits were constructed. Experimental results indicated that typical values for the sum of the rise and delay time of approximately eight nanoseconds could be obtained. Corresponding values for the sum of the storage and fall times were also eight nanoseconds. High speed techniques outlined can be extended to other fast circuits. (auth)

38304 (TID-21900) A TEMPERATURE-COMPENSATED, LOW-POWER ASYMMETRIC ASTABLE MULTIVIBRATOR. Scientific Report No. 9. Brooks, J. C.; Kennedy, E. J.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Aug. 20, 1963. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 92p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A low-power astable multivibrator employing two complementary transistors was analyzed in an effort to achieve both temperature stability and low-power operation. In this circuit both transistors were on simultaneously and off simultaneously. On- and off-periods could be set independently. A low-power circuit was obtained by setting the on-period at a small fraction of the off-time. The original multivibrator circuit operated over a temperature range of 0 to 60°F with widely varying on- and off-periods. Temperature compensating techniques were devised which enable the circuit to operate with relatively constant on- and off-times over a temperature range of 0 to 120°F. The temperature-compensated circuit has a power requirement of 965 microwatts. A lower-power circuit was designed which required only 53 microwatts. However, temperature stability was sacrificed to achieve this smaller power requirement. (auth)

38305 (TID-21920) INPUT IMPEDANCE OF EMITTER FOLLOWERS. Scientific Report No. 15. DeWitt, B. F.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Nov. 1, 1964. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 71p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The input impedance of an emitter follower may be represented by a parallel combination of a resistor and a capacitance where the values of both are functions of the transistor parameters, the load impedance, and frequency. The resistor may have a positive value in one frequency range and a negative value in another range. If the resistance is negative, the circuit may be regenerative and, for certain conditions, may produce oscillations. The input impedance of an emitter follower and methods for stabilizing the circuit were investigated. Calculations using the hybrid-π circuit indicated that the input resistance could be negative only for RC loads and only over a reasonable frequency range. Both above and below this frequency range, the input resistance was positive. Measured values of input impedance agreed reasonably well with the calculated values up to the frequency f_T. Approximate equations were derived for estimating the maximum negative resistance and the frequency at which the maximum value occurred. Simple compensating networks are specified that provide stable operation over an extended range of frequencies. (auth)

38306 (TID-21924) AN EVALUATION OF TWO PROPOSED NOISE MODELS FOR THE FIELD-EFFECT TRANSISTOR. Scientific Report No. 10. Hilger, U. E.; Blalock, T. V.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Aug. 21, 1963. Contract W-7405-eng-26; Subcontract 2160. 86p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A study is presented of two noise models for the field-effect transistor (FET)—Van der Ziel's model, having a thermal noise generator as the chief source, and the model of Lauritzen and Leistike, with a shot noise generator as the primary source. The operation of the FET is briefly discussed. The experimental procedure used in studying white noise is outlined, and the results are shown. Flicker noise was also found, at frequencies above those normally considered. It is shown that both models produce results considerably different from the experimental values. (M.J.T.)

38307 (TID-21930) FAST HYBRID BISTABLE MULTIVIBRATORS. Scientific Report No. 14. Millard, J. K.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of

Electrical Engineering). Oct. 15, 1964. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 70p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Design and test results on two hybrid bistable circuits that may be suitable for high-speed scalers are given. One circuit consisted of a tunnel-diode pair driving a transistor connected in the common-base configuration. The other circuit was similar except that the transistor was connected in the common-emitter configuration. To allow a better evaluation of the hybrid circuits, an emitter-coupled transistor bistable circuit was also tested using similar components and construction techniques. All three circuits were mounted on stripline circuit boards to optimize high-speed performance. The three circuits were triggered with a signal consisting of a pair of closely spaced pulses with the pairs occurring at intervals of one microsecond. The pulse spacing of each pair was varied to determine the maximum repetition rate of each circuit. The common-base circuit responded favorably to pulses spaced at 4.8 nanoseconds. This circuit had a minimum rise time of one nanosecond. The common-emitter circuit responded to a pulse spacing of approximately eight nanoseconds. A circuit is proposed which may offer the best combinations of characteristics for scaling purposes. (auth)

38308 (TID-21934) FAST TUNNEL-DIODE MONOSTABLE MULTIVIBRATORS. Scientific Report No. 13. Oliphant, J. M.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). June 15, 1964. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 123p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Two high-speed tunnel-diode monostable multivibrators, one biased linearly and the other biased nonlinearly, were analyzed to determine their operating characteristics and high speed capabilities. A detailed study of the factors governing the rise time, fall time, pulse duration, and recovery time of the tunnel-diode monostable multivibrator is given. Original theoretical equations are derived for the output pulse duration and the recovery time for both the linear bias and the nonlinear bias conditions. Two circuits, one for each bias condition, were constructed and tested to determine the characteristics of the output pulses. These circuits were capable of generating pulses with durations ranging from five to 80 nsec at a repetition rate of one Mc. The characteristics of the output pulses were determined as a function of the bias point, trigger pulse magnitude, width of the trigger pulse, supply voltage, and temperature. The results predicted using the theoretical equations defining the output pulse width and recovery time are in reasonable agreement with the experimental data. The equations derived are extremely useful in the design of high-speed tunnel-diode monostable multivibrators. (auth)

38309 (TID-21935) PRACTICAL LOW-FREQUENCY LIMITATIONS ON TWIN-TEE FILTERS. Scientific Report No. 16. Parker, O. G.; Johnson, R. G.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Nov. 15, 1964. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 62p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A study was made to ascertain the lowest possible resonant frequency at which a twin-tee amplifier, built from commercially available components, could be operated and still satisfy the following minimum requirements: (1) system gain of −60 db or less at frequencies very far above or below resonance, (2) system gain at resonance of within five per cent of amplifier open loop gain and stable to within two per cent for maximum expected variations in circuit parameters, and (3) resonant frequency within two per cent of its theoretical value for maximum expected variations in circuit parameters. The parameters that were assumed to be variable were the amplifier output resistance, the amplifier input resistance, the driving source internal resistance, and the d-c leakage resistance of the capacitor. A set of theoretical expressions for the system transfer function was derived as each of the parameters was allowed to vary while all others were held constant at their ideal values. These expressions were differentiated with respect to the particular variable parameter and the derivatives were evaluated at the point where the variable parameter assumed its ideal value. The results of these partial derivatives were used to develop approximate equations for variations in gain at resonance and resonant frequency as functions of small variations of the individual parameters from their ideal values. In addition, changes in the value of the center-leg capacitor of the tee were analyzed in the same manner to determine to what extent it could be used in compensating for nonideal values of the other parameters. All expressions were verified experimentally using a specially designed d-c amplifier having a high input impedance. Based on the expression developed in this study and the latest available capacitor specifications, the lowest practical resonant frequency for a twin-tee filter is approximately 0.0059 cps, and is limited by the effect of the leakage resistance on the signal attenuation at frequencies very far below resonance. (auth)

38310 (TID-21938) A STUDY OF THREE ANALOG-TO-DIGITAL CONVERSION TECHNIQUES. Scientific Report No. 17. Reedy, E. K. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Dec. 15, 1964. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26; Subcontract 2160. 97p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The theory of analog-to-digital conversion processes is considered. Three of the most commonly used conversion techniques are discussed and compared. These techniques are the ramp, the cascaded-stages, and the successive-approximation methods. Emphasis is placed on the speed and accuracy of each conversion technique. Ramp conversion is accomplished by performing an intermediate conversion of a pulse height to a time interval and then converting the time interval to a digital number. The analysis of the ramp method illustrates the inherent speed limitation of this technique while emphasizing that the ramp method is capable of producing an extremely accurate digital output with a minimum of circuit complexity. Cascaded-stages conversion uses a weighing or comparison procedure to form the digital representation of an analog number. Each bit of the digital output is formed by a successive comparison of the input signal to a reference voltage weighted in value according to the position in the digital output of its correspondence bit. Since the conversion time of the cascaded-stages method depends primarily on the sum of the settling times of each of its individual stages, this technique has the shortest conversion time of the three methods discussed. The successive-approximation conversion process essentially consists of a step-by-step buildup of a feedback reference voltage by a trial-and-error procedure that involves the generation of a digital output, decoding of the digital output and comparison of the decoded output with the input signal, and alteration of the output until it agrees with the input signal. Of the three methods discussed, the successive-approximation technique represents the best compromise among speed of response, conversion accuracy, and circuit complexity. Comparision of the three coding techniques was achieved by considering several system applications grouped according to their speed and accuracy requirements and indicating which of the conversion techniques could best meet the performance specifications imposed by the system application. (auth)

38311 (TID-22033) AGE AND GROWTH OF THE NORTHERN HOG SUCKER, HYPENTELIUM NIGRICANS IN DOE RUN, MEADE COUNTY, KENTUCKY. Goodyear, Richard H. (Louisville Univ., Ky. Dept. of Biology). [1965]. Contract AT(40-1)-2595. 54p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

Two groups of Hypentelium nigricans from Doe Run, Meade County, Kentucky were used in this study. One group was comprised of various collections made throughout Doe Run, while the other was composed of a single collection made at, and below, Station IV. Scales were removed from the right side of the body between the dorsal fin and lateral line, and were examined with either a con-

ventional scale reader, or an ocular micrometer in a binocular microscope. Annuli were identified on the basis of the relative spacing of the circuli, the cutting-over of circuli near the margin of the lateral and posterior fields, and the wavy character of the circuli produced immediately after formation of the annulus. Sexual maturity was attained between 107 mm and 126 mm standard length for both males and females. Sex ratio was 102 females to 100 males. Annulus formation occurred sometime during late April and May. The relationship between standard length and total length is expressed by two equations: $L_t = 0.1 + 1.24\ L_s$ applies to those fish 22-101 mm standard length, while $L_t = 7.1 + 1.17\ L_s$ fits those 114-290 mm. The length-weight relationship for alcohol preserved specimens, $\text{Log } W = -5.3948 + 3.18 \text{ Log } L_t$, differed from that for the formalin preserved fish, $\text{Log } W = -5.2239 + 3.13 \text{ Log } L_t$. The coefficient of condition behaved as expected from the slopes of the logarithmic length-weight equations. Factors influencing this variable were discussed. The trend in the values of the coefficient of condition, both within and between, age groups was also discussed. The total length as a function of the anterior radius of the scale for formalin preserved fish 95 mm total length and longer was expressed by the equation $L_t = 47.1 + 1.24\ A$. The equation derived for alcohol preserved specimens does not bear a realistic relationship to the former equation. Possible reasons for the discrepancy were discussed. Lee's phenomenon was briefly discussed, and an important factor in its explanation, growth compensation, was shown to occur in Age Group III. The growth pattern for both length and weight was, in general, typical for fishes. The longest fish was a 348 mm (total length) female. (auth)

38312 (TID-22063) SPECTROSCOPIC PROPERTIES OF FLUOROCARBONS AND FLUORINATED HYDROCARBONS. Final Report, June 1, 1965. Nielsen, J. Rud (Oklahoma Univ. Research Inst., Norman). Contract AT (40-1)-1074. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The research on the fundamental vibrational frequencies of fluorinated hydrocarbons is described. A combined normal coordinate analysis was made on CF_3-CH_3 and CF_3-CD_3. The results are expressed in the forms of tables of coordinates, force constants, vibrational frequencies, and transformation matrices. Work on other fluorinated ethanes is also described. (D.L.C.)

38313 (TID-22065) COMPARATIVE ECOLOGY OF THE CRAYFISHES ORCONECTES RUSTICUS RUSTICUS AND CAMBARUS TENEBROSUS IN DOE RUN, MEADE COUNTY, KENTUCKY. Prins, Rudolph (Louisville Univ., Ky. Dept. of Biology). [1964]. Contract AT-(40-1)-2595. 137p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

The ecology and life histories of the crayfishes, Orconectes rusticus rusticus (Girard) and Cambarus tenebrosus Hay, were investigated in a spring stream, Doe Run, Meade County, Kentucky, from September 1962 through September 1964. Differences in ecology of these species were most clearly seen in their habitat preferences and distributions in the stream, their feeding habits, responses to light and temperature, and infestations by a harpacticoid copepod Attheyella carolinensis Chappuis, and in other life history phenomena, particularly with regard to reproduction and growth. (72 references) (auth)

38314 (UCRL-11544) PROPAGATION CHARACTERISTICS OF AN INHOMOGENEOUS COAXIAL CABLE. Large, David B. (Lawrence Radiation Lab., Univ. of California, Berkeley). July 17, 1964. Contract W-7405-eng-48. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI

A solution for the propagation characteristics of an inhomogeneous coaxial line is presented. A particular case is considered. Numerical results from an exact solution are compared with those from an approximate solution. (M.O.W.)

38315 (UCRL-16073) THE ELECTROMAGNETIC LEVITATION OF METALS; THE DESIGN, CONSTRUCTION, AND OPERATION OF A DIFFERENTIAL MICROMANOMETER; AND STUDIES OF ATOMIC HYDROGEN AT LOW PRESSURES (thesis). Rony, Peter Roland (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 26, 1965. Contract W-7405-eng-48. 443p. Dep. mn; CFSTI, $7.43 cy, $2.00 mn.

I. A complete theoretical description of the electromagnetic levitation of metals is given, leading to the basic equations for the lifting force and power input for a metal sphere levitated in an inhomogeneous sinusoidally alternating magnetic field. The suspended metal is suitably controlled either by operation at lower frequencies and addition of heat with an electron beam, plasma-arc torch, high-frequency induction heater, or reflection furnace, or by operation at high frequencies and employment of high-thermal-conductivity gases such as hydrogen and helium to cool the metal. Values indicating the case of levitation of 1-cm-radius spheres of more than 50 different metals at 0°C and at their respective melting points are given. When frequencies in the 10 to 100 kc/sec are used, the density of the metal chiefly determines the ease of levitation. Refractory, semiconducting, or dielectric materials can be levitated either by the heating of them to high temperatures to decrease their electrical resistivity or by the coating of a light and inert metal of high melting point with the material to be studied. Liquid sodium surrounded by a mineral oil of almost identical density can be used in the study of the magnetic-field distribution of levitation coils. Liquid mercury can be used to determine the ability of levitation coils to suspend high-temperature liquid metals. II. A differential micromanometer capable of measuring 100 μtorr to an accuracy of ±2% has been designed, constructed, and tested. The pressure difference is sensed by a membrane manometer constructed as a differential capacitor that forms two legs of a resonant-bridge network excited by a radio-frequency source. The most favorable system found to date consists of a pressure transducer (Decker Corporation Model 306-2A) operated open loop with the bridge and electronics. Differential pressures as low as 50 μtorr can be measured with a zero drift of 1 μtorr per min or 30 μtorr per hour. Differential pressures of 0.5 μtorr are detectable. The micromanometer is calibrated electrostatically. The diaphragm constant K in the formula, $\Delta P = K V^2$, is determined to ±2% by the comparision of a known voltage and a calibrated McLeod gage. III. The theoretical description of diffusion and flow tubes is extended to the following situations: (a) the discharge zone is of finite length, (b) the discharge-zone walls are inactive catalytically, (c) the end-plate sink is composed of two or more catalytic materials, and (d) the atom-recombination coefficients on the discharge- and reactor-zone walls differ in magnitude. The dimensionless groups characterizing the rate processes within the system are systematized. A Wrede-Harteck gage, which is capable of detecting atom concentrations of less than 0.06% at 75 mtorr, indicates that the presence of small amounts of water does not influence the yield of atomic hydrogen from a microwave or 50-MHz discharge. This result is independent of the measurement technique, the source of hydrogen, the source of water, and the discharge power. Small amounts of oxygen stoichiometrically increase the yield of atomic hydrogen from the low-pressure discharge by a ratio of at least two atoms of hydrogen per molecule of oxygen. Molecular nitrogen has a similar but smaller effect. The location of an active catalytic probe affects the atom-concentration level throughout a diffusion tube. A cyclotron-resonant microwave discharge operates in the low-pressure system with powers as low as 250 mw. The intensity of the Balmer lines or color of low-pressure hydrogen discharges is not a reliable qualitative indication of the atomic-hydrogen yield. Requisite conditions for the proper use of an isothermal calorimeter are also discussed. (auth)

38316 (JPRS-29641) TRANSLATIONS ON COMMUNIST CHINA'S SCIENCE AND TECHNOLOGY NO. 172. Apr. 19, 1965. 68p. (TT-65-30762). $3.00(CFSTI).

For abstracts of individual papers see: 35952 and 37548.

38317 APPLICATION OF THE "DISTRIBUTIVE PAIRING" HYPOTHESIS TO PROBLEMS OF SEGREGATION IN TRANSLOCATION HETEROZYGOTES OF DROSOPHILA MELANOGASTER. Chandley, Ann C. (Oak Ridge National Lab., Tenn.). Genetics, 52: 247-58(Aug. 1965). (ORNL-P-667)

Chromosome pairing and disjunction have been studied in female translocation heterozygotes carrying multiple inversions. The results are interpreted on R. Grell's hypothesis of distributive pairing. Three translocations involving exchange between the X chromosome and the right arm of chromosome 2 were chosen deliberately to form a series giving a variety of arm lengths due to reciprocal exchange. The use of the multiply inverted chromosomes FM6 and SM1, either singly or in combination, as the homologues of the translocated X and second chromosome, served to suppress crossing over in various arms and make noncrossovers available for distributive pairing. Results showed a significant increase in X chromosome nondisjunction when FM6 was the only noncrossover in the pool. When a second noncrossover was available to pair distributively with FM6, the level of nondisjunction fell below the control value. When four noncrossovers were made available for distributive pairing by the introduction of both FM6 and SM1, a significant increase in X chromosome nondisjunction was found in Translocation 43. It was a translocation in which the four elements showed great diversity in chromosome length. Some trivalent formation is postulated to account for the increase in nondisjunction. (auth)

38318 QUANTITATIVE ELECTRON MICROSCOPY. Proceedings of a Symposium held at the Armed Forces Institute of Pathology, Washington, D. C., March 30 through April 3, 1964. Bahr, Gunter F.; Zeitler, Elmar H. (eds). Lab. Invest., 14: 739-1340(June 1965). (CONF-753)

Proceedings of a Symposium on Quantitative Electron Microscopy are presented. Topics covered include: physics of image formation quantitative evaluation of electron micrographs, chemical information from electron micrographs, adverse effects of the electron beam limiting interpretation and evaluation of electron micrographs, effects of the preparation procedure on the appearance of the object in electron micrographs, and photography in electron microscopy. Separate abstracts were prepared for four papers. One paper was previously abstracted for NSA and appeared as 18: 44479. (M.C.G.)

For abstracts of individual papers see: 36490, 36491, 36492, and 36493.

38319 EURATOM–PROPOSALS FOR INDUSTRIAL POLICIES AND LONG-RANGE ADVANCE ESTIMATES. Neue Tech., 7: 92-7(Apr. 1965). (In German)

The long-range advance estimates made by Euratom for the years 1970 to 1979 on the electrical consumption in Europe are presented. The role that nuclear energy can play in the fulfillment of these needs and the consequences of such utilization on the various branches of industry with respect to production and investment cost are given. (J.S.R.)

38320 NUCLEAR INSURANCE. Armstrong, G. L. Toronto, Canadian Nuclear Association, 1965, Preprint No. 65-CNA-213, 18p. (CONF-650515-5). ORINS

From International Conference and Exhibition of Canadian Nuclear Assn., Quebec.

Problems involved in the insurance of nuclear facilities are discussed from the standpoint of property damage and public liability. The insurance coverage offered by the Nuclear Insurance Association of Canada is outlined. (C.H.)

38321 AEROSOLS. Physical Chemistry and Applications. Proceedings of the First National Conference held at Liblice near Prague, October 8-13, 1962. Spurny, Kvetoslav. Prague, Publishing House of the Czechoslovak Academy of Sciences, 1965. 943p. (CONF-621004)

Information is included on: physical chemistry of aerosols; radioactive aerosols; aerosols in meteorology and astronomy; industrial aerosols; agricultural aerosols; and biological effects of aerosols. A total of 98 papers are included. (P.C.H.)

38322 THRUST BEARINGS. Rushing, Frank C. (to U. S. Atomic Energy Commission). U. S. Patent 3,202,465. Aug. 24, 1965.

A thrust bearing of the Kingsbury type is designed for a centrifuge. A relatively broad-faced circular member serves as a thrust bearing surface for the shaft. The broad surface is adapted to seat against a plurality of bearing shoes which are resiliently mounted on a stationary bearing block so as to be capable of axial and tilting movement with respect to the rotatable shaft. An auxiliary thrust bearing is also provided for the rotatable shaft. The auxiliary bearing employs hydraulic means for moving and positioning the shaft whereby it may supplant the bearing shoes as a cooperating bearing member for the broad-faced bearing surface when desired. Lubricating fluid is introduced under pressure at the center of the bearing surfaces and is collected at the periphery thereof. (AEC)

38323 ALLOYS AND ELECTRICAL TRANSDUCERS. Krinsky, A. (to U. S. Atomic Energy Commission). U. S. Patent 3,202,951. Aug. 24, 1965.

A new alloy is described which exhibits resistance to oxidation with minimal electrical conducting change up to temperatures of about 400°C and also resistance to attack by corrosive agents. The alloy is of iron, aluminum, and titanium in the composition range of 25 to 30 atomic percent iron, 35 to 50 atomic percent aluminum, and 20 to 40 atomic percent titanium. This alloy is useful in electrical resistance elements subjected to oxidizing conditions at elevated temperatures and as a protective coating in corrosive applications. (AEC)

CORPORATE AUTHOR INDEX

This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt.," permitting a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

A

ADVANCE RESEARCH, INC., NEEDHAM HEIGHTS, MASS.
Critical industry repair analysis—food industry, final report, 19: 36701 (CIRA-3)

AEC COMPUTING AND APPLIED MATHEMATICS CENTER, NEW YORK UNIV., N. Y.
Variational studies of few body nucleus, 19: 37798 (NYO-1480-18)

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ä	becomes	ae
ö		oe
ø		oe
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SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium — Isotopes He-4 or Helium — He-4 Isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid — methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ζ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names, are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly. Cross references appear in the index cumulations. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

Specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Whenever it appears that such information would be useful, descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract. Such phrases are written so that the idea considered most important is presented first. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium–allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been

omitted from such phrases provided no ambiguity results from the omission.

For entries concerned with physics, if the modifier does not indicate whether the reference is experimental or theoretical, a symbol E or T or E/T is given.

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If published proceedings are received after the receipt of individual papers, the complete proceedings will be abstracted and the abstract number will appear in this index with the base CONF number.

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CONF-652–		(American Industrial Hygiene Association Pacific Northwest Section Meeting, Richland, Wash., Aug. 28–29, 1964)
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CONF-812–		(Society for Applied Spectroscopy 3rd National Meeting, Cleveland, Sept. 28–Oct. 2, 1964)
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CONF-591001–	19-36968	(Symposium on New Physical and Chemical Properties of Metals of Very High Purity, Paris, Oct. 12–14, 1959)
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CONF-640305–	19-35884	(5th Inter-American Symposium on the Peaceful Application of Nuclear Energy, Valparaiso, Chile, Mar. 9–13, 1964) Proceedings
CONF-640411	19-37135	(Conference on Advances in Aerospace Materials, Orlando, Fla., Apr. 16–17, 1964)
CONF-640509–		(Colloquium on Theoretical Physics, Bordeaux, May 1964)
1	19-37536	See N64-26098
CONF-640530–		(International Congress on the Sea, Saint-Cast, France, May 30–June 7, 1964)
1	19-36702	See EUR-2407.f

Report No.	Abstract No.	Availability
CONF-640621–	19-37910	(International Symposium on Diffusion of Plasma Across a Magnetic Field, Feldafing/Starnberger See, Germany, June 29–July 3, 1964)
CONF-640706–		(Sulfur Conference, Berkeley, Calif., July 8–10, 1964)
1	19-37047	See UCRL-16075
CONF-640915–		(Pisa Symposium on Natural Philosophy, Pisa, Italy, Sept. 17–21, 1964)
1	19-37673	See UCRL-11921
CONF-641001– (Vol.II)	19-36320	(Symposium on Radiochemical Methods of Analysis, Salzburg, Austria, Oct. 19–23, 1964) See STI-PUB/88(Vol.II)
CONF-650111–		(CERN Informal Neutrino Conference, Geneva, Jan. 1965)
5	19-36803	See BNL-9146
CONF-650218–		(International University Sessions on Nuclear Physics, Schladming, Austria, Feb. 25–Mar. 10, 1965)
1	19-37528	See IC/65/27
CONF-650302–		(IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna, Mar. 1965)
20	19-36699	See BNWL-SA-5
CONF-650306–	19-37263	(Particle Accelerator Conference, Washington, D. C., Mar. 10–12, 1965)
CONF-650313–		(Symposium on Nuclear Medicine, Philadelphia, Mar. 19–20, 1965)
2	19-36815	See ORNL-P-1383
CONF-650320–		(IEEE International Convention, New York, Mar. 1965)
1	19-36755	See SC-R-65-855
CONF-650401–		(American Chemical Society, Detroit, Apr. 4–9, 1965)
6	19-36805	See BNWL-SA-121
CONF-650405–		(International Conference on Modern Trends in Activation Analysis, College Station, Tex., Apr. 19–22, 1965)
5	19-36229	See BNWL-SA-137
CONF-650407–		(International Symposium on Fission Product Release and Transport Under Accident Conditions, Oak Ridge, Tenn., Apr. 1965)
8	19-38132	See ORNL-P-1287
9	19-36700	See BNWL-SA-9
10	19-37198	See BNWL-SA-123
CONF-650410–		(American Physical Society, Washington, D. C., Apr. 26–29, 1965)
2	19-37522	Dep.(mn); $2.00(cy), 1(mn) CFSTI
CONF-650414–		(19th Metallographic Group Meeting, Oak Ridge, Tenn., Apr. 20–22, 1965)
3	19-36954	See IS-1184
CONF-650416–		(4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif., Apr. 26–28, 1965)
4	19-36643	ORINS
5	19-36642	ORINS
7	19-36645	ORINS
CONF-650437–		(Cyclotron Colloquium, Eindhoven, Netherlands, Apr. 1965)
1	19-37246	See NIRL/R/85
CONF-650501–		(The Application of Computing Methods to Reactor Problems, Argonne, Ill., May 17–19, 1965)
2	19-38130	See ORNL-P-874
13	19-38131	See ORNL-P-1272
CONF-650502–		(Electrochemical Society, San Francisco, May 9–14, 1965)
1	19-36341	See ORNL-P-862
2	19-36342	See ORNL-P-899
3	19-36340	See ORNL-P-814
CONF-650504–		(IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Germany, May 10–14, 1965)
38	19-37762	See KFK-301
39	19-38128	See KFK-302
40	19-38273	See KFK-303
CONF-650505–		(IFIP Congress 1965 Meeting, New York, May 24–29, 1965)
3	19-36908	See ORNL-P-1303
CONF-650507–		(IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna, May 24–28, 1965)
35	19-36228	See BNWL-SA-119
CONF-650510–		(Purdue Conference on Instrumentation for High Energy Physics, Lafayette, Indiana, May 11–15, 1965)
4	19-36804	See BNL-9218
5	19-36816	See PPAD-2137-549
6	19-36812	See MIT-2098-155
7	19-36821	See UCRL-11995
CONF-650512–	19-37944	(Symposium on Engineering Problems of Controlled Thermonuclear Research, Livermore, Calif., May 4–7, 1965)
CONF-650515–		(International Conference and Exhibition of the Canadian Nuclear Assn., Quebec, Canada, May 9–12, 1965)
2	19-38290	ORINS
4	19-38217	ORINS
5	19-38320	ORINS
6	19-38218	ORINS
7	19-38216	ORINS
8	19-36743	ORINS
9	19-36741	ORINS
10	19-38282	ORINS
11	19-38167	See AECL-2214
14	19-38219	ORINS
16	19-36742	ORINS
CONF-650517–		(American Society of Quality Control, Albany Section, Latham, N. Y., May 6, 1965)
1	19-36630	Dep.(mn)
CONF-650520–		(IAEA Symposium on Exchange Reactions, Upton, New York, May 31–June 4, 1965)
1	19-36456	See NYO-2499-16
CONF-650523–		(Symposium on Radiation and Terrestrial Ecosystems, Richland, Wash., May 3–5, 1965)
2	19-36708	See NYO-3273-5
CONF-650524–		(European Nuclear Energy Agency and Atomic Energy Commission Seminar, Upton, N. Y., May 3–7, 1965)
2	19-37784	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CONF-650525–		(International Conference on the Internal Conversion Process, Nashville, Tenn., May 10–13, 1965)
2	19-37826	See ORNL-P-1248
3	19-37827	See ORNL-P-1256
4	19-37837	See UCRL-16027
CONF-650526–		(7th Tripartite Instrumentation Conference, London, May 15, 1965)
1	19-36806	See BNWL-SA-163
CONF-650527–		(Association for Computing Machinery, Rio Grande Chapter Meeting, Phoenix, Ariz., May 13–14, 1965)
1	19-38298	See SC-DC-65-1428
CONF-650532–		(Institute of Nuclear Materials Management Meeting, Cincinnati, May 10, 1965)
1	19-38185	See ORNL-P-1278
CONF-650533–		(American Assn. on Contamination Control, Annual Meeting, Miami, Fla., May 25, 1965)
1	19-36591	See Y-EA-37

Report No.	Abstract No.	Availability
CONF-650535–	(10th Annual Minerals Symposium, Grand Junction, Colo., May 7–8, 1965)	
1	19-36588	See UCRL-14197-T
CONF-650601–	(Symposium on Working Methods in High-Activity Hot Labs., Paris, June 1965)	
1	19-36573	See ORNL-P-861
CONF-650602–	(American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn., June 20–24, 1965)	
2	19-37044	See RL-SA-20
4	19-38192	See WCAP-5494
5	19-38229	See WCAP-5492
6	19-36824	See WCAP-5482
7	19-38193	See WCAP-5495
9	19-38191	See WCAP-5490
10	19-36709	See ORNL-P-1034
11	19-36979	See LA-DC-6965
12	19-38239	See LA-DC-6958
13	19-38242	See LA-DC-7003
14	19-38240	See LA-DC-6968
15	19-36750	See LA-DC-6973
17	19-38274	See LA-DC-6972
18	19-38243	See LA-DC-7005
25	19-37767	See WAPD-T-1788
26	19-37785	Dep.(mn); $1.00(cy), 1(mn) CFSTI
28	19-38173	Dep.(mn); $2.00(cy), 1(mn) CFSTI
30	19-38228	See BNL-9271
31	19-38083	See WAPD-T-1791
34	19-38134	See WAPD-T-1792
CONF-650603–	(Joint Meeting of the American Institute of Chemical Engineers and the British Institution of Chemical Engineers, London, June 13–17, 1965)	
1	19-36614	See WCAP-5449
2	19-38286	See HW-SA-3604
CONF-650605–	(Conference on Design of Leak Tight Fluid Connectors, Huntsville, Ala., June 9–10, 1965)	
1	19-38241	See LA-DC-6979
CONF-650606–	(EURATOM Symposium on Fuel Cycles of High-Temperature Gas-Cooled Reactors, Brussels, June 10–11, 1965)	
7	19-38174	See GA-6367
CONF-650610–	(American Institute of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, Colorado Springs, Colo., June 14–18, 1965)	
2	19-38141	ORINS
4	19-37197	ORINS
5	19-38255	ORINS
6	19-37146	ORINS
7	19-38215	ORINS
8	19-38256	ORINS
9	19-36644	ORINS
10	19-38252	ORINS
13	19-38254	ORINS
14	19-38258	ORINS
15	19-38253	ORINS
17	19-37017	ORINS
18	19-38257	ORINS
CONF-650611–	(Symposium on Heat Flow Below 100°K and Its Technological Applications, Grenoble, France, June 9–11, 1965)	
2	19-36634	See LA-DC-7224
4	19-36335	See LA-DC-7218
CONF-650613–	(American Chemical Society, 20th Northwest Regional Meeting, Corvallis, Oregon, June 14, 1965)	
3	19-36435	See BNWL-SA-213
CONF-650615–	(IAEA Panel on Utilization of Thorium in Power Reactors, Vienna, June 14–18, 1965)	
2	19-38187	See ORNL-TM-1147
3	19-37175	See ORNL-TM-1142
4	19-38186	See ORNL-TM-1145
CONF-650616–	(Health Physics Society, Annual Meeting, Los Angeles, June 14–17, 1965)	
1	19-36238	See RFP-510
2	19-36125	See RL-SA-15
CONF-650617–	(Vacuum Metallurgy Conference, New York, June 21–23, 1965)	
1	19-37043	See ORNL-P-1394
2	19-37003	See UCRL-12487
CONF-650618–	19-36625	(18th Meeting of the Heat Transfer and Fluid Mechanics Inst., Los Angeles, June 21–23, 1965)
CONF-650619–	(2nd Topical Conference on Resonant Particles, Athens, Ohio, June 10–12, 1965)	
1	19-37539	See ORNL-P-1386
CONF-650621–	(Special Technical Meeting on Use of Remote Access, Time Sharing Computer Systems, Schenectady, N. Y., June 1–2, 1965)	
1	19-38295	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CONF-650622–	(Hydraulics Colloquium, Iowa City, Iowa, June 6–9, 1965)	
1	19-36754	See SC-DC-65-1482
CONF-650624–	(2nd International Conference on Lung Tumors in Animals, Perugia, Italy, June 24–29, 1965)	
1	19-35943	See BNWL-SA-147
CONF-650628–	(American Chemical Society, Northwest Regional Meeting, Richland, Wash., June 14, 1965)	
1	19-36455	See BNWL-SA-199
CONF-650629–	(Conference on Small-Angle X-Ray Scattering, Syracuse, N. Y., June 24–26, 1965)	
1	19-38028	See ORNL-P-1396
CONF-650630–	(Society of Physical Chemistry, 15th Annual Meeting, Paris, June 1–4, 1965)	
1	19-36436	See ORNL-P-1366
CONF-650631–	(International Powder Metallurgical Conference, New York, June 14–17, 1965)	
1	19-37004	See Y-DA-732
CONF-650701–	(Colloquium on Physical Chemistry of Protactinium, Paris, July 2–8, 1965)	
1	19-36538	See MLM-1233J
2	19-36539	See MLM-1234J
3	19-36333	See LA-DC-6899
4	19-36334	See LA-DC-6900
CONF-650702–	(American Electroplater's Convention, New York, July 12–15, 1965)	
1	19-36948	See BDX-613-66
CONF-650704–	(IAEA Symposium on Thermodynamics, Vienna, July 22–27, 1965)	
2	19-37172	See ORNL-P-1397
CONF-650706–	(International Conference on the Study of Nuclear Structure with Neutrons, Antwerp, July 19–23, 1965)	
1	19-37825	See ORNL-P-1226
14	19-37793	See MIT-2098-152
16	19-37828	See ORNL-P-1375
17	19-37758	See BNL-9243
CONF-650801–	(IUPAC Meeting on Macromolecular Chemistry, Prague, Aug. 30–Sept. 4, 1965)	
1	19-36454	See BNL-9104
CONF-650804–	(5th Rare Earth Research Conference, Ames, Iowa, Aug. 30–Sept. 1, 1965)	
1	19-37453	See BNL-9244
CONF-650806–	(7th International Conference on Phenomena in Ionized Gases, Belgrade, Aug. 22–27, 1965)	
2	19-37928	See MATT-333
CONF-650901–	(Symposium on Evolving Genes and Proteins, New Brunswick, N. J., Sept. 17–18, 1965)	

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1	19-38291	See BNL-8825
CONF-650902–	**(American Chemical Society, 150th National Meeting, Atlantic City, Sept. 12–17, 1965)**	
1	19-37028	See BDX-613-69
3	19-36537	See LA-DC-7066
CONF-650903–	**(Symposium on Structural Adhesives, Castle Point Station, N. J., Sept. 14–16, 1965)**	
1	19-36995	See BDX-613-68
CONF-650904–	**(Symposium on Radiation Effects, Asheville, N. C., Sept. 8–10, 1965)**	
1	19-37171	See ORNL-P-1108
2	19-37157	See BNL-9127
3	19-37163	Dep.(mn); $1.00(cy), 1(mn) CFSTI
4	19-37164	Dep.(mn); $1.00(cy), 1(mn) CFSTI
5	19-37159	See BNL-9289
6	19-37173	See ORNL-P-1448
7	19-37162	See BNWL-SA-236
8	19-37174	See ORNL-P-1481
9	19-37160	See BNL-9290
10	19-37158	See BNL-9264
CONF-650905–	**(American Institute of Chemical Engineers Symposia, Minneapolis, Sept. 26–29, 1965)**	
1	19-36608	See IS-1137
CONF-650911–	**(2nd Conference on Plasma Physics and Controlled Nuclear Fusion Research, Abingdon, Berks., England, Sept. 6–10, 1965)**	
1	19-37937	See ORNL-P-1429
5	19-37945	See UCRL-14243
6	19-37943	See UCRL-12434
CONF-651101–	**(13th Conference on Remote Systems Technology, Washington, D. C., Nov. 15–18, 1965)**	
2	19-36590	See WAPD-T-1690
COO–		
1198-266	19-38025	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1199-6	19-36651	Dep.(mn); $4.00(cy), 3(mn) CFSTI
1371-1	19-37523	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1428-12	19-37524	Dep.(mn); $2.00(cy), 1(mn) CFSTI
CU–	**(Misc.)**	
1932-241	19-37525	Dep.(mn); $2.00(cy), 2(mn) CFSTI
1932-243	19-37526	Dep.(mn); $4.00(cy), 3(mn) CFSTI
D–	**(Misc.)**	
1-82-0388	19-37908	
1-82-0389	19-37669	
1-82-0395	19-37909	
1-82-0417	19-37490	
2-20275-1	19-37034	See N64-27085
2-90418-6	19-38016	See N64-29368
2-90418-7	19-36124	See N64-29369
DASA–	**(Misc.)**	
1549	19-36632	See AD-608531
DESY–	**(German)**	
65/2	19-37527	Dep.(mn)
DP–		
926	19-38089	Dep.(mn); $1.00(cy), 1(mn) CFSTI
962	19-36522	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
964	19-38262	Dep. mn; CFSTI, $2.00 cy, $0.50 mn
DPSPU–		
64-30-19	19-35905	Health Phys., 11: 780-3(1965)
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EAC–		
6	19-37942	See TID-22045
EGG–		
1183-2020	19-37369	IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 3, 830-5(1965)
EUR–	**(European Atomic Energy Community)**	
2093	19-36998	See EURAEC-1296
2249.e	19-36330	Dep. mn
2407.f	19-36702	Dep. mn
EURAEC–		
618	19-36965	Dep.(mc); $4.60(fs), $1.58(mf) OTS
1241	19-36747	See CEND-3336-223
1296	19-36998	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1311	19-38264	See GEAP-4781
1409	19-37780	See BAW-3125-4
FSD-ING–	**(Canadian)**	
10	19-37245	Dep.; $2.00(AECL)
FTD-TT–	**(Non-AEC)**	
63-1018	19-37049	CFSTI
64-1381	19-36770	CFSTI
65-82	19-37431	CFSTI
65-342	19-37199	CFSTI
FZK–	**(Non-AEC)**	
224	19-36865	CFSTI
GA–	**(Misc.)**	
5339	19-36231	See N64-27382
5594	19-37428	See N64-32896
6094	19-36649	See AD-614997
6367	19-38174	Dep.(mn); $2.00(cy), 1(mn) CFSTI
GAMD–	**(Misc.)**	
5958	19-38263	Dep.(mn); $2.00(cy), 1(mn) CFSTI
GEAP–	**(Misc.)**	
4445	19-38175	Dep. mn; CFSTI, $3.00 cy, $0.75 mn
4578	19-38176	Dep. mn; CFSTI, $4.00 cy, $1.00 mn
4580	19-38124	Dep.(mn); $3.00(cy), 1(mn) CFSTI
4780	19-38177	Dep.(mn); $3.00(cy), 2(mn) CFSTI
4781	19-38264	Dep.(mn); $1.00(cy), 1(mn) CFSTI
4790	19-38178	Dep.(mn); $5.00(cy), 3(mn) CFSTI
4805	19-38078	Dep. mn; CFSTI, $4.00 cy, $0.75 mn
4817	19-38125	Dep.(mn); $2.00(cy), 1(mn) CFSTI
GEMP–	**(Misc.)**	
47A	19-36951	Dep.(mn); $4.00(cy), 2(mn) CFSTI
88	19-38090	Dep.(mn); $2.00(cy), 1(mn) CFSTI
89	19-36748	Dep.(mn); $3.00(cy), 1(mn) CFSTI
90	19-38091	Dep.(mn); $3.00(cy), 1(mn) CFSTI
359	19-38231	Dep.(mn); $4.00(cy), 2(mn) CFSTI
HIC–	**(Non-AEC)**	
45	19-36633	See AD-608206
HW–		
61236(Suppl.6) (Rev.)	19-38265	Dep.(mn); $2.00(cy), 1(mn) CFSTI
72229(Rev.)	19-36703	Dep.(mn); $1.00(cy), 1(mn) CFSTI
84608	19-38079	Dep.; $3.00(cy), 2(mn) CFSTI
84609	19-38080	Dep.(mn); $3.00(cy), 2(mn) CFSTI
HW-SA–		
3330	19-38232	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3599	19-38230	Nucl. Appl., 1: 267-70(1965)
3604	19-38286	Dep. mn; CFSTI, $2.00 cy, $0.50 mn
3730(Rev.)	19-36129	Ind. Med. Surg., 34: 335-7(1965)
IA–	**(Non-AEC)**	
1003	19-36810	Dep. mn
1009	19-36331	Dep. mn
IAE–	**(Non-AEC)**	
744	19-37256	For translation see SLAC-Trans-16
772	19-37797	Dep. mn
796	19-37796	Dep. mn
810	19-37454	Dep. mn
IC–	**(Misc.)**	

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65/27	19-37528	Dep.(mn)
65/53	19-37670	Dep. mn
65/61	19-37671	Dep. mn
65/65	19-37529	Dep. mn
IDO–		
14656	19-36217	Dep.(mn); $2.00(cy), 1(mn) CFSTI
17054	19-38269	Dep.(mn); $3.00(cy), 1(mn) CFSTI
17065	19-38233	Dep. mn; CFSTI, $3.00 cy, $0.75 mn
17089	19-37786	Dep.(mn); $1.00(cy), 1(mn) CFSTI
17102	19-38270	Dep.(mn); $2.00(cy), 1(mn) CFSTI
24044	19-38271	Dep.(mn); $4.00(cy), 3(mn) CFSTI
IFA-CR–	**(Rumanian)**	
52	19-37787	Dep.(mn)
IFA-IS–	**(Rumanian)**	
31(1965)	19-36332	Dep.(mn)
IIB–	**(German)**	
12	19-37702	See AD-608474
IITRI–	**(Misc.)**	
578P21-9	19-38092	Dep.; $6.00(cy), 6(mn) CFSTI
3203-5	19-36745	See AD-426242
B6040-2	19-36978	
INP–	**(Polish)**	
407/PL	19-38026	Dep.
INR–	**(Polish)**	
588/IX/R	19-36607	Dep.
591.IA/PL	19-37788	Dep.
IPP–	**(Non-AEC)**	
2/36	19-37910	Dep.(mn)
4/17	19-37515	Dep.(mn)
IS–		
785	19-37075	Am. Soc. Testing Mater., Proc., 64: 734-46(1964)
1072	19-36811	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1076	19-37464	J. Chem. Phys., 43: 856-61(1965)
1137	19-36608	Dep. mn; CFSTI, $2.00 cy, $0.50 mn
1168	19-37116	Phys. Rev. Letters, 15: 262-3(1965)
1177	19-37684	Nuovo Cimento (10), 38: 1441-3(1965)
1184	19-36954	Dep.(mn); $2.00(cy), 1(mn) CFSTI
IS-T–		
12	19-37789	Dep.(mn); $3.00(cy), 2(mn) CFSTI
14	19-38296	Dep.(mn); $2.00(cy), 1(mn) CFSTI
32	19-36536	Dep. mn; CFSTI, $2.00 cy, $0.50 mn
JINR–	**(Russian)**	
E-2108	19-37530	Dep.(mn)
P-2093	19-37790	Dep.(mn)
P-2098	19-37531	Dep.(mn)
P-2114	19-37791	Dep.(mn)
P-2126	19-37532	Dep.(mn)
JPL-TR–	**(Non-AEC)**	
32-673	19-36336	See N64-33904
JPRS–	**(Non-AEC)**	
29641	19-38316	$3.00(CFSTI)
29788	19-35877	CFSTI, $3.00 cy
30769	19-36890	CFSTI, $1.00 cy
30771	19-36891	CFSTI, $1.00 cy
30907	19-36244	CFSTI, $1.00 cy
30925	19-37200	CFSTI, $2.00 cy
30963	19-36691	CFSTI, $1.00 cy
JüL-Bibl.–	**(German)**	
8	19-38093	Dep.(mn)
9	19-38272	Dep.(mn)
K–		
1633	19-36900	Dep.; $2.00(cy), 1(mn) CFSTI
1643	19-36901	Dep.(mn); $5.00(cy), 3(mn) CFSTI
K-P–		
3248	19-36230	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
KAPL-M–		
6186(Rev.II)	19-37760	Dep.(mn); $2.00(cy), 2(mn) CFSTI
6429	19-36902	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6452	19-37792	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6456	19-36903	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6471	19-37761	Dep.(mn); $1.00(cy), 1(mn) CFSTI
KFK–	**(German)**	
301	19-37762	Dep. mn
302	19-38128	Dep. mn
303	19-38273	
KLX–	**(Misc.)**	
1872	19-36873	Dep. mn; CFSTI, $3.00 cy, $0.75 mn
KY–		
484	19-35886	Dep.(mn); $1.00(cy), 1(mn) CFSTI
LA–		
3235	19-36218	Dep. mn; CFSTI, $4.00 cy, $0.75 mn
3249	19-36219	Dep. mn; CFSTI, $2.00 cy, $0.50 mn
3262	19-37203	Dep. mn; CFSTI, $2.00 cy, $0.50 mn
3278	19-36885	Dep.; $2.00(cy), 1(mn) CFSTI
3286	19-38234	Dep. mn; CFSTI, $4.00 cy, $0.75 mn
3292	19-36904	Dep.(mn); $2.00(cy), 1(mn) CFSTI
3296	19-38235	Dep.(mn); $2.00(cy), 1(mn) CFSTI
3313	19-38236	Dep.(mn); $2.00(cy), 1(mn) CFSTI
3322	19-37533	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3336	19-38237	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
LA-DC–		
6369	19-37064	Acta Cryst., 19: 224-7(1965)
6447	19-38238	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
6549	19-37050	Acta Cryst., 19: 6-9(1965)
6580	19-37032	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6731	19-36551	Ind. Eng. Chem., Fundamentals, 4: 308-13(1965)
6750	19-37115	Phys. Rev., 139: A437-41(1965)
6793	19-37067	Acta Cryst., 19: 281-3(1965)
6826	19-36415	J. Phys. Chem., 69: 2464-9(1965)
6899	19-36333	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
6900	19-36334	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
6904	19-36371	Inorg. Chem., 4: 1237-9(1965)
6958	19-38239	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
6965	19-36979	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
6968	19-38240	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
6972	19-38274	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
6973	19-36750	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
6975	19-36366	Inorg. Chem., 4: 985-6(1965)
6979	19-38241	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
7001	19-36368	Inorg. Chem., 4: 1166-70(1965)
7003	19-38242	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
7005	19-38243	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
7066	19-36537	Dep. mn; CFSTI, $2.00 cy, $0.50 mn
7139	19-38013	Dep. mn; CFSTI, $3.00 cy, $0.50 mn
7218	19-36335	Dep. mn; CFSTI, $2.00 cy, $0.50 mn
7224	19-36634	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
LAL–	**(French)**	
1138	19-37534	Dep. mn
1139	19-37535	Dep.(mn)
LAMS–		
3017	19-37033	Dep.(mn); $4.00(cy), 2(mn) CFSTI
MATT–		
268	19-37927	Dep.(mn); $3.00(cy), 2(mn) CFSTI
333	19-37928	Dep. mn; CFSTI, $2.00 cy, $0.50 mn
MIT–	**(Misc.)**	
2098-119	19-37678	Ann. Phys. (N. Y.), 33: 328-359(1965)
2098-128	19-37676	Ann. Phys. (N. Y.), 33: 272-4(1965)
2098-130	19-37687	Phys. Rev., 139: B751-4(1965)
2098-142	19-36220	Dep.(mn); $5.00(cy), 3(mn) CFSTI
2098-155	19-36812	Dep.(mn); $1.00(cy), 1(mn) CFSTI
2098-152	19-37793	Dep.(mn); $1.00(cy), 1(mn) CFSTI

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ML-TDR-	**(Non-AEC)**	
64-62(Vol.II)	19-36945	See AD-610867)
MLM-		
1233J	19-36538	Dep. nn; CFSTI, $1.00 cy, $0.50 mn
1234J	19-36539	Dep. nn; CFSTI, $1.00 cy, $0.50 mn
1243J	19-36555	J. Inorg. Nucl. Chem., 27: 1701-11(1965)
1250	19-36889	Dep.(nn); $2.00(cy), 1(nn) CFSTI
1255J	19-37011	J. Vacuum Sci. Technol., 2: 215-16(1965)
MND-	**(Misc.)**	
3169-16	19-36886	Dep.(nn); $1.00(cy), 1(nn) CFSTI
MPI-PA-	**(Misc.)**	
29/64	19-37929	Dep.(nn)
MR-	**(Non-AEC)**	
25118	19-36635	See N64-26583
N-	**(Misc.)**	
64-20815	19-36955	CFSTI, $1.60 cy
64-22477	19-37930	
64-23372	19-37704	$1.25(CFSTI)
64-24160	19-38244	CFSTI
64-26098	19-37536	Dep. nn
64-26583	19-36635	CFSTI, $8.60 cy
64-27085	19-37034	
64-27247	19-37705	CFSTI, $1.60 cy
64-27248	19-37931	CFSTI, $2.60 cy
64-27250	19-37706	CFSTI, $3.60 cy
64-27382	19-36231	CFSTI, $1.60 cy
64-29195	19-37035	CFSTI, $1.60 cy
64-29197	19-37707	CFSTI, $2.60 cy
64-29222	19-36636	CFSTI, $6.60 cy
64-29363	19-38014	CFSTI, $11.50 cy
64-29364	19-37491	CFSTI, $7.60 cy
64-29365	19-38015	CFSTI, $2.60 cy
64-29368	19-38016	CFSTI, $2.60 cy
64-29369	19-36124	CFSTI, $3.60 cy
64-29689	19-37932	CFSTI, $4.60 cy
64-29727	19-38245	
64-32896	19-37428	CFSTI, $1.00 cy, $0.50 mn
64-33085	19-37036	CFSTI, $1.25 cy
64-33160	19-37708	CFSTI, $3.00 cy
64-33174	19-37037	CFSTI, $1.00 cy
64-33326	19-37038	CFSTI, $1.00 cy
64-33564	19-37933	CFSTI, $2.00 cy, $0.50 mn
64-33627	19-37709	CFSTI, $3.00 cy
64-33632	19-37934	CFSTI, $1.00 cy
64-33635	19-37935	CFSTI, $2.00 cy
64-33904	19-36336	CFSTI, $1.00 cy
64-33921	19-37735	CFSTI, $2.00 cy, $0.50 mn
65-20670	19-36866	
251	19-37255	For translation see AEC-tr-6581
NAA-SR-		
10485	19-36540	Dep. nn; CFSTI, $2.00 cy, $0.50 mn
10486	19-36541	Dep. nn; CFSTI, $2.00 cy, $0.50 mn
10717	19-38246	Dep.; $3.00(cy), 2(nn) CFSTI
11123	19-36609	Dep.(nn); $2.00(cy), 1(nn) CFSTI
11235	19-36337	Dep. nn; CFSTI, $1.00 cy, $0.50 mn
NAA-SR-Memo-		
3830	19-38179	Dep.(nn); $1.00(cy), 1(nn) CFSTI
9623	19-36905	Dep.(nn); $3.00(cy), 2(nn) CFSTI
9624	19-36906	Dep.(nn); $2.00(cy), 1(nn) CFSTI
10676	19-38247	Dep.(nn); $1.00(cy), 1(nn) CFSTI
10720	19-38180	Dep.(nn); $1.00(cy), 1(nn) CFSTI
NASA-CR-	**(Misc.)**	
54040	19-36635	See N64-26583
54099	19-36231	See N64-27382
54149	19-36636	See N64-29222
54160	19-38245	See N64-29727
54393	19-37039	
56190	19-36955	See N64-20815
56229	19-38244	See N64-24160
56291	19-37930	See N64-22477
56939	19-37707	See N64-29197
58288	19-37035	See N64-29195
58292	19-38014	See N64-29363
58293	19-37491	See N64-29364
58294	19-38015	See N64-29365
58297	19-38016	See N64-29368
58298	19-36124	See N64-29369
58567	19-37932	See N64-29689
58774	19-37037	See N64-33174
59018	19-37428	See N64-32896
59199	19-37708	See N64-33160
59273	19-37038	See N64-33326
59347	19-36243	See X64-17610
59369	19-37735	See N64-33921
59382	19-36336	See N64-33904
NASA-SP-	**(Misc.)**	
7017	19-37429	CFSTI, $1.50 cy
NASA-TM-	**(Non-AEC)**	
X-1111	19-36751	CFSTI, $1.00 cy
X-55007	19-37705	See N64-27247
X-55010	19-37931	See N64-27248
X-55013	19-37706	See N64-27250
X-55076	19-37934	See N64-33632
X-55078	19-37709	See N64-33627
X-55083	19-37935	See N64-33635
X-55091	19-37933	See N64-33564
NASA-TN-	**(Misc.)**	
D-2138	19-37704	See N64-23372
D-2207	19-37168	CFSTI, $0.75 cy
D-2503	19-37036	See N64-33085
D-2787	19-36752	CFSTI, $1.00 cy
D-2909	19-37794	$1.00(CFSTI)
D-2924	19-36610	CFSTI, $2.00 cy
NASA-TT-	**(Non-AEC)**	
F-169	19-37947	CFSTI, $1.00 cy
NBS-	**(Misc.)**	
8508	19-37037	See N64-33174
8556	19-37038	See N64-33326
NBS-TN-	**(Misc.)**	
210	19-37710	$0.30(GPO)
251	19-36956	GPO, $0.45
NDL-TM-	**(Non-AEC)**	
20	19-38287	
NEVIS-	**(Misc.)**	
135	19-37525	See CU-1932-241
137	19-37526	See CU-1932-243)
NIRL-R-	**(British)**	
85	19-37246	Dep. nn; BIS, $0.70; HMSO, 3s. 6d.
NLCO-		
907	19-36718	Health Phys., 11: 731-5(1965)
NMI-	**(Misc.)**	
8001.1	19-36999	
NP-	**(AEC File No. for Non-AEC Reports)**	
14902	19-35944	Dep.(nn)
15082	19-35892	Dep.(nn)
15094	19-38017	
15105	19-36704	Dep.(nn)
15106	19-37711	
15107	19-36585	
15109	19-37795	
15113	19-36957	
15115	19-37169	
15118	19-37040	
15120	19-37516	
15121	19-36611	
15129	19-37517	
15133	19-37000	
15135	19-37936	
15139	19-36958	
15146	19-36705	Dep.(nn)

Report No.	Abstract No.	Availability
15147	19-37537	
15148	19-36637	
15160	19-36338	
15170	19-36100	Dep. mn
15174	19-37041	
15181	19-36706	
15184	19-35945	
15189	19-37204	Dep. mn
15266	19-36707	CFSTI
NP-tr-	**(AEC File No. for Non-AEC Translations)**	
1271	19-36245	Dep. mn; JCL, $1.60 fs, $0.80 mf
NRL-	**(Misc.)**	
F15	19-35892	See NP-15082
NSJ-tr-	**(Japanese)**	
20	19-36690	Dep. mn; JCL, $2.60 fs, $0.83 mf
37	19-38196	Dep. mn; JCL, $2.60 fs, $1.10 mf
NYO-		
1480-18	19-37798	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1480-20	19-37455	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1864-21	19-35946	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
1930-43	19-37799	Dep.(mn); $4.00(cy), 3(mn) CFSTI
2499-16	19-36456	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3000-7	19-36339	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3185-1	19-36457	Dep. mn; CFSTI, $3.00 cy, $0.75 mn
3234-1	19-35893	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
3273-5	19-36708	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3334-1	19-36458	Dep. mn; CFSTI, $3.00 cy, $0.75 mn
3364-3	19-36652	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3364-5	19-36653	Dep.(mn); $2.00(cy), 1(mn) CFSTI
3399-36	19-37538	Dep.(mn); $2.00(cy), 1(mn) CFSTI
3429-3	19-37518	Dep.(mn); $2.00(cy), 1(mn) CFSTI
ORNL-		
3655	19-38297	Dep.(mn); $3.00(cy), 1(mn) CFSTI
3742(Rev.)	19-36907	Dep.; $3.00(cy), 1(mn) CFSTI
3778	19-37205	Dep.; $6.00(OTS)
3800	19-37822	Dep.; $4.00(cy), 2(mn) CFSTI
3807	19-38181	Dep.(mn); $7.00(cy), 5(mn) CFSTI
3841	19-38027	Dep.(mn); $4.00(cy), 2(mn) CFSTI
ORNL-P-	**(Misc.)**	
100	19-37189	Nucl. Sci. Eng., 22: 420-33(1965)
102	19-35995	Exptl. Cell Res., 38: 570-9(1965)
455	19-36255	Anal. Chim. Acta, 33: 76-83(1965)
574	19-36831	Health Phys., 11: 759-62(1965)
599	19-36403	J. Inorg. Nucl. Chem., 27: 1557-69(1965)
608	19-35923	Nature, 206: 51-4(1965)
667	19-38317	Genetics, 52: 247-58(1965)
701	19-37010	J. Electroanal. Chem., 9: 253-9(1965)
730	19-36437	Acta Cryst., 19: 260-8(1965)
748	19-38129	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
814	19-36340	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
861	19-36573	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
862	19-36341	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
874	19-38130	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
881	19-36384	J. Chem. Eng. Data, 10: 237-8(1965)
899	19-36342	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
943	19-37472	Phys. Rev., 139: A401-9(1965)
971	19-36542	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
981	19-36176	J. Nucl. Med., 6: 409-20(1965)
1023	19-36556	J. Phys. Chem., 69: 2374-7(1965)
1024	19-36391	J. Electroanal. Chem., 9: 305-10(1965)
1034	19-36709	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
1046	19-36894	Z. Naturforsch., 20a: 663-6(1965)
1055	19-36557	J. Phys. Chem., 69: 2378-82(1965)
1108	19-37171	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
1159	19-37688	Phys. Rev., 139: B756-60(1965)
1174	19-37862	Phys. Rev., 139: B567-78(1965)
1226	19-37825	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1248	19-37826	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1249	19-36719	Health Phys., 11: 743-57(1965)
1256	19-37827	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1272	19-38131	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1278	19-38185	Dep. mn; CFSTI, $1.00 cy, $0.50 mn
1287	19-38132	Dep. mn; CFSTI, $2.00 cy, $0.50 mn
1303	19-36908	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1348	19-37475	Phys. Rev. Letters, 15: 254-7(1965)
1366	19-36436	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1375	19-37828	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1383	19-36815	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1386	19-37539	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1394	19-37043	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1396	19-38028	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1397	19-37172	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1429	19-37937	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1448	19-37173	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1481	19-37174	Dep. mn; CFSTI, $2.00 cy, $0.50 mn
ORNL-RSIC-		
4	19-37764	Free (ORNL)
ORNL-TM-		
1032, pp 18-25	19-37253	
1048	19-38275	Dep.(mn); $4.00(cy), 2(mn) CFSTI
1082	19-37250	Dep. mn; CFSTI, $2.00 cy, $0.50 mn
1082, pp10-17	19-37252	
1082-27, pp 1-9	19-37251	
1126	19-37938	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1142	19-37175	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1145	19-38186	Dep.(mn); $2.00(cy), 1(mn) CFSTI
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1150	19-37176	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1165	19-37001	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1172	19-37672	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1173	19-37736	Dep.(mn); $3.00(cy), 1(mn) CFSTI
1189	19-38188	Dep. mn; CFSTI, $2.00 cy, $0.50 mn
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587	19-38094	Dep.(mn); $1.60(fs), $0.80(mf) JCL
ORO-		
606(Suppl.I)	19-38189	Dep.(mn); $4.00(cy), 3(mn) CFSTI
PAEC(A)IN-	**(Philippines)**	
645	19-36753	Dep. mn
PATENTS	**(British)**	**(3s. 6d. each, U. K. Patent Office)**
988,778	19-36796	
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989,115	19-36861	
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1,188,295	19-36991	
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1,191,501	19-38103	
1,191,502	19-36601	
1,191,582	19-37019	
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618,925	19-38094	For translation see ORNL-tr-587
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25,808 Re.	19-36628	
3,175,720	19-38107	
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3,202,951	19-38323	
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153,139	19-36770	For translation see FTD-TT-64-1381
PG-Report–	**(British)**	
374	19-36232	Superseded by PG-Report-585
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